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The Effect of Sand Grain Size on the Rate of Melting and Refining of Soda-Lime Glass

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The question of the effect of the shape and grading of sand grains on the rate of melting and refining of soda-lime glass is one which is at present receiving some attention. One large glass sand supply company is selling its sand under a guarantee that it is within certain limits of mesh size.

It is generally believed that a sand, the grains of which are of medium size, will give the best melting results, but just what that uniform size should be is not generally agreed upon. In most cases it is stated that a sand of which most of the particles are about 60 mesh will give the best results; on the other hand, an old window glass maxim states that "the coarse sand gives the best glass." It is generally felt that the use of a very fine sand is not advisable because by its use in a pot excessive foaming results. In a tank it causes an excessive amount of material to be carried into the checkers. Under favorable conditions it appears to give a fine seed. It has been pointed out by several investigators that a large part of the undesirable iron and titanium containing minerals which occur in glass sands, such as magnetite, rutile, and ilmenite are concentrated in the finer portions of the sand, so that sifting out the fine parts of a glass sand tends to lower the iron content of the sand. When the iron impurity is in the form of a thin coating of hydrated iron oxide or clay on the sand grains, the same thing holds true, for the finer the sand the greater is its surface in proportion to its weight, and the greater its surface the greater is the amount of iron-containing coating the sand has.

A glass batch of any particular composition will always give a glass of the same composition and properties when completely melted independently of variations in the size of the particles composing it. But a particular batch will often give different working results in different localities, even under the same working conditions, because of varying size of sand and lime particles used in the two localities.

The first action in the formation of glass depends on the chemical reaction or combination between soda ash and sand. The speed of any chemical reaction or solution is largely determined by the intimacy of contact between the reacting substances; that is, in the melting of glass it depends on how easily the soda ash and sand can get at each other. The soda ash can act only on the surface of the sand grains because it cannot penetrate into them; so that the speed of this action depends on the amount of surface that the sand grains expose to the action of the soda ash. The greater this surface, the more rapid is the action.

As the diameter, or mesh size, of the sand particles decreases, the amount of surface per unit weight increases rapidly. For example, a certain weight of round sand grains of 100 mesh size will have almost six times the amount of surface as the same weight of grains of 20 mesh size. Accordingly, other factors being equal, the speed of melting or solution of the 100 mesh sand will be almost six times as fast as that of the twenty mesh sand.

With irregular shaped sand grains, the surface exposed is greater than when the grains are rounded because of the corners and edges which the irregular shaped grains possess; accordingly, the irregular shaped grains flux into glass somewhat more rapidly than the rounded grains.

The grains of water laid glass sands, such as those of the Oriskany and other formations in Pennsylvania, West Virginia, and other eastern states, are irregular in shape, while the wind deposited glass sands of the St. Peter formation in Missouri and Illinois are more or less rounded in shape. For this reason, the eastern sands will flux into glass somewhat more rapidly than the sand of the same mesh size from the St. Peter formation. Because of the rounded shape of the grains, it was thought for a long time that the sands of the St. Peter formation would not be serviceable for glass, but a trial of these sands soon showed this belief to be erroneous.

As the rate of melting of the batch increases rapidly with decreasing size of sand or lime grains, it would appear, if rapid melting is desirable, that the best sand to use would be that composed of the smallest grains. It is questionable, however, if rapid melting above a certain point is as desir-

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ROUNDED SAND GRAINS FROM OTTAWA DISTRICT, ILLINOIS

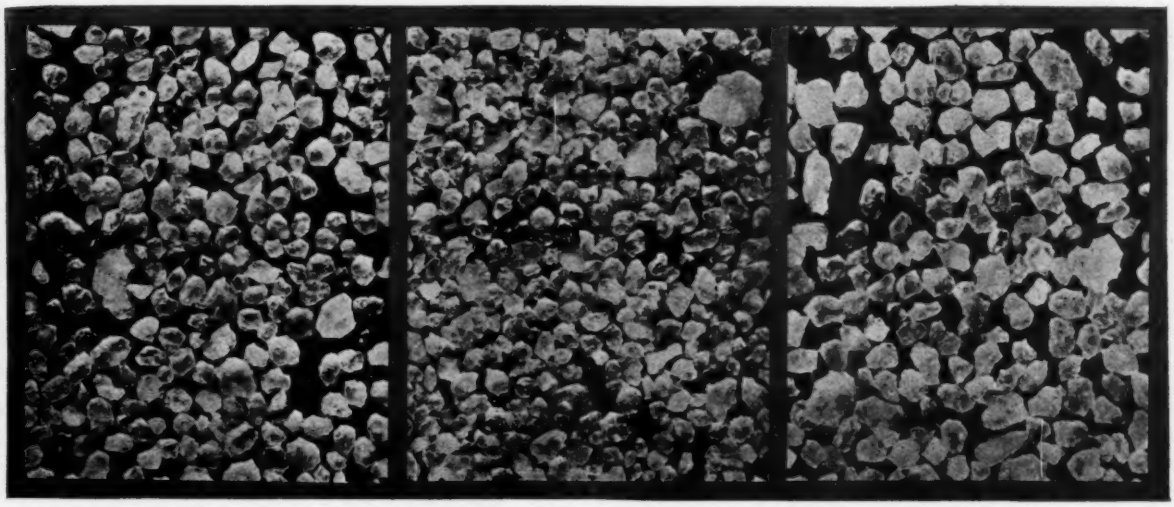
able as it is generally believed to be. A commercial glass must not only be completely melted but should also be completely refined. The important point is not merely to obtain a glass which melts within a short period of time, but to get a glass batch which both melts and refines within the shortest time possible. The melting and the refining of glass are entirely different operations. They are, to a large extent, independent of each other and do not necessarily proceed in the same order, that is, if the rate of melting is increased in some manner, the rate of refining is not necessarily correspondingly increased. On the contrary, it may be slowed up, and this, in fact, is what obtains when the rate of melting is increased by the use of fine sand or lime.

The ordinary soda-lime glass, such as that used for bottle or window glass is composed of approximately six equivalent parts of silica, one of lime, and one of sodium oxide (the base of soda ash). If each part of lime be considered as combined with one part of silica, there will remain about five parts of silica to each part of sodium oxide. The assimilation of these five parts of silica into the glass takes place in two distinct stages. In the first stage, one equivalent or part of soda combines with one or two parts of silica to form a sodium silicate and in the second stage, the remaining three or four parts of silica slowly dissolve in or combine with this molten sodium silicate. That is, in the melting of a soda-lime batch, the soda ash does not act directly on all the sand present, but merely combines with part of the sand to form a material (sodium silicate) which then, in turn, dissolves or combines with the remainder of the sand.

In the interaction of the soda ash and the sand there is set free a volume of gas equal to one thousand times or more the volume of the batch. All but a very small portion of this gas must be removed from the glass before it can be considered as plained. If all this gas were retained in the melting mass it would swell up in a mass of foam so great in size that only a very small amount of glass could be melted at one time without overflowing the container. However, the melting mass will retain only a small portion of the gas at any one period and most of the gas formed will escape as soon as it is formed without affecting the total amount of gas retained in the melting mass. The amount retained, and consequently the amount of swelling of the batch depends on the character of the batch, on the ease with which the gas can escape from the batch and on the rate of action of the soda ash on the sand, being greater in a confined space as in a pot and with increasing rate of action as when fine sand is used.

The gas formed from the soda ash is evolved entirely during the first stage of the melting, that is, during the reaction of the soda ash with a portion of the sand to form a sodium silicate. The subsequent solution of the remaining sand causes no further gas evolution. Since the amount of gas evolved during any period of the first stage of melting is greatly in excess of the amount which the melting batch can retain in the form of gas bubbles, effective refining in any portion of the melting glass cannot begin until the first stage of the melting is completed, that is, until the soda ash in that part of the melting batch has entirely reacted with silica. There is ordinarily no sharp line of separation between the two stages of glass melting, the second stage proceeding to some extent during the course of the first. The coarser the sand, the sharper is the division between the two stages.

As stated above, the final composition of the glass from any particular batch is independent of variations in size of the particles constituting the batch and consequently the final viscosity is similarly so independent. But, the fact is usually overlooked that while the final viscosity of the glass is independent of grain size variation, the course of viscosity changes during the melting process is almost entirely dependent on grain size, and the viscosity changes during the melting have considerable influence on the process of refining. That is, two piles of batch of the same chemical composition (containing the same amount of sand, soda ash, etc.) will, when completely melted, give glasses of the same viscosity at any particular temperature even if the sand and lime are very coarse in one and very fine in the



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ANGULAR SAND GRAINS FROM PENNSYLVANIA

other, so that the rate of refining will be the same in the completely melted glasses from the two batches. However, the viscosity, and consequently the rate of refining at different periods of the melting will differ greatly in the two batches.

Considerable refining of the glass takes place between the point where all the soda ash has reacted and effective refining begins and the point where melting is completed, that is, during the second stage of the melting. The amount of refining which takes place during this stage depends on the length of time the glass is in this stage of the melting process and on the course of viscosity changes during this stage. The greater the degree of refining which takes place during this stage, the less refining is necessary after melting is completed.

Suppose the first action of the soda ash on the sand produces a silicate containing one equivalent of soda to one of silica. When all the soda ash has gone to form this silicate effective refining begins. The rate of movement of the gas bubbles through the melting mass depends on the amount of friction between the gas bubbles and the medium through which they are moving, and this, in turn, depends on their size, on the viscosity of the fluid present and on the amount of friction which develops between the separate solid particles and between the solid particles and the bubbles. The size of the bubbles depends on their initial size and on the ease with which they can coalesce to form larger bubbles. The initial size of the bubbles and the ease with which they can coalesce depend on the surface tension of the liquid medium and on its viscosity. The amount of friction developing between the solid particles and the bubbles depends on the size of the particles and their uniformity, being, with any definite weight of solid material, much greater with small particles and non-uniform size than with large particles and uniform mesh size. The greater this friction the slower the movement of the gas bubbles. That is, large and uniform sized grains offer less resistance to the movement of gas bubbles than small non-uniform sized grains of the same aggregate weight.

When the first stage of the melting process is completed without the simultaneous action of the second stage, that is, when all the soda ash reacts with silica without more than a minimum of silica being dissolved in the silicate first formed, the viscosity of the fluid medium present is at a minimum. Consequently the initial size of bubbles and the ease of their coalescence are greatest, and the rate of refining is at a maximum. As more silica and lime dissolve the viscosity increases rapidly and the rate of bubble movement decreases correspondingly. The larger the sand grains the sharper is the division between the two stages of melting, and consequently the lower is the viscosity and the greater the rate of refining at the beginning of effective refining. As has been said, the larger the sand grains the slower they melt or dissolve, and as the viscosity of the liquid medium increases rapidly with increasing solution of silica, the slower the rate of solution of the silica, the slower the decrease in rate of refining during the course of the second stage of the melting. Consequently, the slower the rate of melting of the glass during this second stage, the more refining is effected during this stage and the less refining is necessary after melting is completed.

It would appear that the effect of this would be merely to shorten the refining period somewhat and to lengthen the melting period, and that no saving in the length of heat treatment would be effected. It should be remembered, however, that in the ordinary glass melt the refining period is much longer than the melting period. A glass which is not ready to work in a pot until twenty to thirty hours after filling, may have been completely melted four to six hours after filling—so that a shortening of the refining period will allow a shorter furnacing period—that is an increased pull—even if the length of the melting period is simultaneously increased.

Moreover, the rate of refining of the completely melted glass is much slower than that of the partially melted glass because of the higher viscosity of the former consequent to its higher content of silica and lime. The effect of increase in silica content on the viscosity of the melt

can be seen from the following figures taken from the work of Washburn and Sheldon:

Composition	Viscosity in poises @ 2200° F.	@ 2550° F.
Silica—49.7%, Soda—50.3%	8.5	....
Silica—60 %, Soda—40 %	110.0	18.
Silica—70 %, Soda—30 %	420.0	77.
Silica—82.6%, Soda—17.4%	4,900.0	430.

The first combination is that which would be formed under ideal conditions as the sole product of the first stage of the melting; and the last combination is formed from a ratio of soda and silica similar to that in which they would be present in some soda-lime glasses. The range in viscosities shown above probably never obtains in a commercial glass melt—because the second stage of melting takes place to some extent simultaneously with the first; moreover, the presence of a large amount of solid particles in the early part of the second stage tends to offset the low viscosity of the liquid medium present.

The presence in the batch of considerable feldspar or other material which would melt down quickly and the products of solution of which will tend to shorten the viscosity range during the second melting period by giving a relatively high viscosity at the beginning of this period will tend to hold back refining and to cause a fine seed.

It is generally believed that the use of a sand containing a large amount of fine material will, under favorable conditions, cause a fine persistent seed. This is not primarily because the gas bubbles formed from the fine sand particles are initially small in size, for the volume of the gas bubbles at glass melting temperatures is some six thousand times the volume of the sand grain from which it would form, so that a sand grain of 150 mesh size would give a gas bubble about two millimeters in diameter. Moreover, the fine sand is that which is first completely dissolved so that the gas formed from the fine sand is formed at a point in the melting process where coalescence of the gas bubbles is easiest due to the low viscosity of the fluid medium and the high gas pressure present and the gas bubbles subsequently formed tend to sweep out the finer bubbles first formed.

The bubbles at melting temperature are of course, somewhat larger than the same bubbles at ordinary temperatures because of the contraction they undergo on cooling, but the contraction of the gas bubbles takes place only insofar as the pressure on the bubble is greater than the resistance opposed to the volume change by the increasing viscosity of the glass; so that the seed in glassware at ordinary temperature are under a pressure less than atmospheric.

The tendency of fine sand to cause seed is not due primarily to the initial small size of the bubbles formed from the small sand grains, but to the fact that as the fine sand grains dissolve very rapidly the increase in viscosity of the fluid medium takes place very rapidly. Because of this rapid increase in viscosity the small bubbles subsequently formed do not have the freedom of movement or coalescence which they would otherwise have and cannot as readily clear from the glass. The tendency of a fine sand to cause seed is increased by the use of cullet with the batch; the use of a very large amount of cullet can itself cause seed and probably for the same reason. Molten soda ash will react with high silica cullet at a lower temperature and more rapidly than it will with sand. The action of a large amount of cullet is to give a high viscosity at the beginning of the second stage of melting, and thus to slow up refining.

From the above it would appear that the sand which would require the shortest time for combined melting and refining would be one composed of a combination of coarse sand and sufficient very fine sand to react with the soda ash. The fine sand would cause a very rapid initial melting action while the coarse sand would cause a slow secondary stage. In this way, the increase in viscosity would be slow, the total refining period would be shortened and if the sand was not too coarse, melting would be completed before refining. In practice, however, the use of cullet takes the place of fine sand. It is customary to use 800-1,200 pounds of

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ANGULAR SAND GRAINS FROM WEST VIRGINIA

cullet per ton of sand. This amount of cullet ordinarily contains sufficient silica to react with the soda ash used in the batch and to convert the lime in the cullet and the soda in the batch and cullet to normal silicates.

The coarser the sand used, the greater is the tendency for the formation of batch scum. However, from the examination of small melts, the writer believes that it is possible to make good glass commercially from sand which is very much coarser than that ordinarily used provided the sand is uniform as to size and the melting operation is kept free from other factors which might cause scum formation. Under good melting operation a sand containing only a few per cent of coarse grains is more likely to cause scum, stones or silica knots or cords than a sand in which all the grains are uniformly coarse.

The action of the soda ash or the glass on the sand grains is, of course merely a surface action as the molten soda ash cannot penetrate below the surface of the grains to get at the sand below the surface. As the sand grain dissolves it becomes smaller and as it becomes smaller its rate of solution tends to increase in proportion to its mass. This is offset by the fact that as the solution tends towards saturation the rate of solution decreases. The dissolving of silica on the surface of the grains tends to form at this point a solution high in silica and consequently of high viscosity. During the first stage of the melting the evolution of gas which takes place simultaneously with the solution of the silica, removes the layer of silica solution or compound from the surface of the sand grains as it forms and allows fresh soda ash to act on the grains. During the second stage of

the melting, there is no such gas evolution and the only factors present which tend to remove the layer of high silica and high viscosity melt from the surface of the grains is the movement of gas bubbles through the mass and diffusion from the high silica layer into the surrounding more fluid medium. As the viscosity increases throughout the mass of melting batch through solution of silica and lime, the rate of movement of the gas bubbles and the rate of diffusion decrease. But with increasing solution of the silica the size of the sand grains also decreases. Unless the initial size of the sand grains is excessive, their size is small at the point where diffusion and bubble movement are too slow for complete mixing. Therefore, the quantity of high silica glass formed from their complete solution is not large enough to show as a cord or knot. This is especially true of the lower layers of a pile of batch in a tank which clear first of gas bubbles, while the upper layers are agitated by the passage of bubbles from all the layers below them.

In the ordinary soda-lime glass the solution of the last ten per cent of silica causes the greatest increase in viscosity and consequently the greatest decrease in the rate of diffusion and bubble movement. If the sand grains are uniform in size, the attack on them will be approximately uniform and consequently they will decrease in size at a uniform rate. On the other hand, if the sand is composed of a few per cent of large grains and the remainder relatively small grains, the solution of the small grains will be completed before the large grains have decreased but very little in size because of the much greater speed of solution or melting of the small grains. The solution of the large grains will then be taking place at a point where solution speed is slowest because the solution will then be near its saturation point in silica at that temperature. The viscosity will be near the maximum so that diffusion and bubble movement will be very slow. If then, the larger grains are not allowed for solution an amount of time much greater than the melt is usually given, they will not be completely vitrified and will remain undissolved as small stones or will agglomerate into a mass of scum; or, if vitrified, they will remain incompletely mixed as small cords.

When limestone is used in the batch, a very large amount of gas is evolved from this material also. However, as the decomposition pressure of limestone at glass melting temperatures is very high, the evolution of gas from this material can be considered as being aside from the melting process. It is probable that the gas evolved from the limestone is evolved early in the melting and that the only effect of this gas evolution is to decrease slightly the speed of the action of the soda ash on the sand in the first stage of the melting.

SUMMARY

The melting of an ordinary glass batch, as far as the soda or other alkali is concerned, takes place in two stages. In the first stage the soda ash or other alkaline compound reacts with a portion of the sand to form a simple alkali silicate—evidently that consisting of one equivalent of silica to one of alkali.

In the second stage, the remainder of the silica dissolves in or combines with the alkali silicate formed in first stage.

The evolution of the gas which necessitates refining of the glass takes place entirely during the first stage of the melting.

Considerable refining of the glass can take place during the second stage of the melting, and the amount which takes place during this stage determines to a large extent the necessary length of refining period to which the glass must be subjected.

As the rate of refining of the glass is much greater during the second stage of melting than it is in the completely melted glass, it is advisable that the rate of increase in viscosity during the second stage be held back as much as is possible without introducing scum formation by decreasing the rate of silica assimilation during this stage, through the use of a sand which is uniform in size and the particles of which are not too fine.

The Fusibility and Viscosity of Glass*

By Ad. Lecrenier† and P. Gilard§

I Fusibility

As is well known, glasses do not undergo fusion in the physical sense of the word. They do not have a fixed fusion point; in other words, there is no fixed temperature at which the glass passes from the solid to the liquid state. The heating curve of glass does not show the horizontal section of fusion.

When the temperature of glass is raised it becomes gradually softer, first pasty, then more fluid. For this reason science considers glasses, rigid in the cold state, not as solids (though having their principal characteristics) but as liquids of such viscosity that they have the aspects of solids.

Molten glass on cooling loses its temperature, but not its heat of fusion. It remains therefore in a state of a liquid, appearing like a solid only through the gradual increase in viscosity. It is in an unstable condition, in a state of supercooling, which may disappear under certain conditions by the crystallization of glass, by devitrification, a phenomenon which causes the liberation of the heat of fusion. This liberation of heat is clearly evident when the heat of solution of amorphous and that of devitrified glass in hydrofluoric acid is compared.

For the working of glass the glass blower uses the range of the cooling curve corresponding to the viscous state. It is important that this range be as extended as possible. Its length varies with the composition of the glass. Therefore there can be no question of determining with exactness the fusibility of glasses. All that can be done is to estimate in some way or other the degree of softening which they undergo under predetermined conditions.

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Grenet[1] has tried to determine the softening curve by fixing for each glass three temperatures corresponding to three characteristic conditions of glass, namely, the temperatures of softening, annealing and tempering. The work of Grenet is of the greatest interest and utility.

We consider that for practical purposes the determination of the time necessary to fuse a given weight of glass is an index as to the relative fusibility of different glasses.

For our study the following method has been used: The degree of fusibility of a glass is determined by measuring the time necessary to fuse a piece of glass of known weight at a given temperature.

The time is measured between the moment that a tubular platinum crucible, containing the cold glass, is introduced into the furnace heated to the temperature of the test, and the moment that marks the appearance of the first drop of molten glass, falling from the tube. The number of seconds necessary for the fusion of glass at a certain temperature is called "fusibility number." The relation of this number to that of a standard glass is called "coefficient of fusibility."

This method is not exempt from criticism, but appears to be sufficient from a practical point of view.

In order to obtain comparable results and to avoid errors due to the time necessary for the molten glass to move to the outlet tube, the glass, placed in the platinum crucible in small pieces, is given a preliminary fusion until the fall of the first drop. The crucible is then removed from the muffle, allowed to cool completely and weighed. The weight of the empty crucible has been determined previously. It is then replaced in the muffle and the time noted. The time between this moment and the fall of the first drop of glass is observed. The diameter of the outlet tube must of course be the same in all the tests.

By applying this method to some glasses we have obtained the following results:

Composition of glasses examined	Weights of glass to be melted (grams)	Time of fusion	Fusibility number	Coefficient of fusibility, 6 SiO_2, CaO, Na_2O=1
6 SiO_2, CaO, Na_2O	7.5350	9'10"	73	1
6 SiO_2, CaO, ½Na_2O, ½K_2O	7.3460	14'30"	118	0.61
6 SiO_2, ½CaO, ½MgO, Na_2O	6.2000	16'45"	162	0.41
6 SiO_2, ½CaO, ½MgO, K_2O	9.5070	42'10"	266	0.272
6 SiO_2, ½CaO, ½Al_2O_3, Na_2O	7.4815	94'	750	0.098

Of these glasses the most fusible is 6 SiO_2, CaO, Na_2O. The partial or total replacement of soda by potash decreases the fusibility of the glass. Substitution of lime by magnesia has a similar effect. Partial substitution of lime by alumina causes a marked decrease in fusibility. These results are in accord with observations made in practice.

II Viscosity

Among the fundamental properties of glass, one of the most important from a practical point of view is undoubtedly the viscosity. It is due to this property that molten glass remains plastic at a temperature well below that of complete fluidity, and allows the working of the glass by the glass blower.

This property is of prime importance in the operation of annealing, during which the internal strains set up while working the glass are relieved. Failure to do this correctly results in almost certain breakage.

The viscosity of molten glass varies with the temperature and with the composition of the glass. A number of methods have been devised for its determination. Greiner[2] measured the speed with which a platinum rod is lifted up out of molten glass by a constant force. The viscosity of the glasses tested was compared with that of sodium silicate (Na_2SiO_3) taken as a standard. The latter was mixed with various substances in different proportions such as the silicates of iron, manganese, magnesium, calcium, aluminum, etc.

Greiner observed the increase in viscosity caused by the substitution of soda by potash and also by the introduction of lime and alumina in mixtures of sodium silicate and silica. Noteworthy is the reduction of viscosity caused by ferrous and ferric oxides, magnesia and manganese oxide.

Arndt[3] observed the rapidity of the descent of an oblong platinum object in molten glass. This platinum object was suspended to a wire which ran over a small wheel provided with a needle movable over a graduated scale. The sinking of the platinum object was regulated by a counterweight. The viscosity was measured by the product of the time of the fall and the excess of weight causing the descent.

Vesely[4] melted a small globule of glass between two small hooks made of an alloy of platinum and iridium. These hooks and the globule were suspended vertically in the interior of a tubular furnace. The temperature was measured with a thermocouple. The upper hook was attached to a wire passing through the lid of the furnace, and running over a pulley. It carried a counterweight.

When the furnace had the proper temperature, a weight was attached to the lower hook with a metal wire. The two wires were connected with the circuit of a cell and galvanometer. The drop of glass acted as an insulator until the moment that the glass was penetrated by the wires under the action of the weights and made contact. When this happened the circuit was closed and the galvanometer showed a deviation. The viscosity was measured by the time passing between the attachment of the lower weight and the moment of contact.

By means of this apparatus, Vesely studied the influence of various metallic oxides on the viscosity of glass. The results are relative and are expressed in comparison with a standard glass.

Frink[5] measured the viscosity of glass by allowing it to flow through a slot, while in a viscous condition. The slot measured 100 × 3 millimeters, and was made in the bottom of a container filled with molten glass at a fixed temperature and at a pressure of 100 millimeters of mercury. The viscosity is proportional to the size of the strip of glass produced at the time when it becomes of constant width and is expressed as the relation between this width and that of the aperture.

[1] *Bull. Soc. Enc.*

[2] Dissertation, Univ. of Jena, 1907.
[3] *Z. Chem. Apparatenkunde*, 1908.
[4] *Sprechsaal* 44, 451 and 456 (1911).
[5] *Trans. Amer. Cer. Soc.* 12, 585 (1910).

Staley[6] measured the viscosity of borate glasses by the speed of descent of a hollow platinum cylinder suspended by a wire from one of the arms of a balance, into molten glass.

Doelter[7] determined the absolute viscosity of molten silicates by measuring the speed of penetration of a platinum ball, six millimeters in diameter, into molten glass. He demonstrated especially the influence caused by slight variations of temperature. The viscosities are expressed relative to that of pure ricinis oil, which has a known viscosity.

Williams and Cox[8] studied the influence of the temperature variations on the viscosity of glass, by plunging a platinum rod into molten glass.

Field[9] in his studies of blast furnace slag measured the viscosity by the relative rotation of two cylinders, turning in the molten mass at temperatures varying from 1275° to 1575°. The results are expressed in absolute units.

Washburn and Shelton[10] measured the viscosity of a series of technical soda-lime glasses by a method similar to that of Field. The glass was in a cylindrical porcelain container, which was rotated by a special device. The temperature could be read at any time by means of thermocouples. The viscosity was expressed in absolute units. The instrument was standardized by means of liquids of known viscosity.

Other methods have been worked out, which permit the measurement of the viscosity of glasses at a temperature near the softening point, where the methods described above do not apply. Among these, the following may be mentioned: (a) The method of Zschimmer[11], intended to measure the "cohesion point," but which can also serve as a measure of the viscosity. It is based on interference phenomena, produced when two flat, perfectly polished surfaces are brought in contact. A black central spot, surrounded by colored rings can then be observed. At the temperature of softening of the glass, the adherence of the pieces in contact is changed into cohesion. The central black spot expands until it covers the whole contact surface. The temperature at this moment is the "cohesion point." By plotting the time of heating against the cohesion points a curve is obtained, giving an idea as to the viscosities of different glasses.

(C) Twyman's method,[12] in which a glass rod, exactly measured between two marks is fastened at one end, while a known weight is suspended at the other end. This rod is placed in a tubular furnace at the desired temperature and its increase in length under the influence of the weight is carefully measured. This method actually measures the mobility which is the reciprocal value of the viscosity.

The most interesting, the most complete and the most recent study is that made by English,[13] who observed the mobility of glasses of different kinds of known composition and at an interval of temperature extending from the annealing temperature to about 1,400° C. The methods used are different for low and for high temperatures. In the first instance, the mobility is determined by measuring the speed with which the sample is elongated by the action of a weight. The heating apparatus consists of a vertical electric furnace, closed at its upper end by a cover through which passes a thermocouple, and which carries in the center a brass tube into which hangs a nichrome wire fastened to the test piece. The latter, a glass rod with rings at both ends, carries a second wire extending through the bottom of the furnace, fastened to a long needle which forms a lever. One of the ends of this needle rests on a fixed support. The other is movable over a graduated scale, when at a certain temperature, acted on by a weight, the sample is elongated.

At high temperatures a modification of the rotation method of Margules is used. The glass is contained in a cylindrical porcelain vessel of uniform diameter, placed in an electric furnace, and held in a fixed position by supports of sillimanite. The temperature is measured by a thermocouple, the junction of which is located at the surface of the molten glass. In this molten glass a cylinder of platinum-iridium rotates, held by a porcelain rod which is connected with the rotating instrument. The apparatus is standardized by using a sirup of known viscosity, similar to that of molten glass. The method differs from that of Washburn and Shelton by the experimental arrangement.

The researches of English are of great interest. They include soda lime, soda magnesia, soda alumina and potash lead glasses. The mobility and viscosity of these types of glasses were studied between 500° and 1400° C.

Evidently there is no lack of methods to measure the viscosity of glass. From a practical point of view many are worthy of interest. The majority give the relative viscosity, others the absolute viscosity. The latter, while undoubtedly useful from a scientific point of view, is less so to the manufacturer, which fact explains why relative values usually have been found sufficient. To the glass maker the fact that a certain modification of the composition gives a glass with a viscosity so and so much greater than the glass which he uses currently, is more concrete information than the knowledge that the viscosity has been increased by a certain number of units. He is of course inclined to make comparisons with the glass that he uses.

The observations made during our studies of the surface tension of glass have led us to utilize our experimental apparatus for measuring the viscosity of the glasses studied, and to investigate the influence of the various constituents on the viscosity.

Especially the variations observed during the flowing of drops of a certain weight of glass appears to offer a basis for a method of measurement.

This method is really a modification of Frink's method which is also based on the flowing of glass through an orifice. It consists in measuring the time interval between the fall of two consecutive drops of glass flowing through a circular aperture of known diameter, and calculating the time necessary for the outflow of one gram of this glass. The results are expressed in seconds and as the viscosity number is taken the relation between the value found and that given by a standard glass; for instance the theoretical 6 SiO_2, CaO, Na_2O, taken as a unit. Our experiments have been carried out at 1050° and 1150° C. The results obtained for different glasses are given in the following table:

[6] Eighth Intern. Congress of Applied Chemistry, 1912.
[7] *Chemiker Zeitung*, 369, No. 61 (1912).
[8] *Trans. Amer. Cer. Soc.*, 1916.
[9] Bureau of Mines Technol. Paper No. 157, 1916.
[10] Univ. of Ill. Bull., 14-4-'24.
[11] *Silicat Zeitschrift*, 2, 129 (1914).
[12] *J. Soc. Glass Tech.* 1 (1917).
[13] *J. Soc. Glass Tech.* VII, No. 25 (1923), VIII, No. 31 (1924).

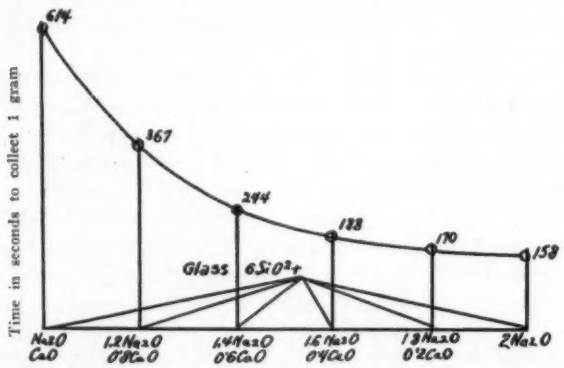
VISCOSITY AT 1050° C.

Composition of glasses examined	Time interval between each drop	Weight of the drop	Time needed for the outflow of 1 gram
6 SiO_2, CaO, Na_2O	3'30"	342 mg	10'14"
6 SiO_2, 0.8 CaO, 1.2 Na_2O	2'4"	338.7	6'7"
6 SiO_2, 0.6 CaO, 1.4 Na_2O	1'28"	333.2	4'24"
6 SiO_2, 0.4 CaO, 1.2 Na_2O	1'1"	324.6	3'8"
6 SiO_2, 0.2 CaO, 1.8 Na_2O	56"	319.8	2'50"
6 SiO_2, 2 Na_2O	50"	315.9	2'38"
5 SiO_2, CaO, Na_2O	3'	324.7	9'14"
6 SiO_2, 1.2 Na_2O, CaO	2'8"	334.5	6'23"
6 SiO_2, Na_2O, MgO	13'36"	346	39'18"
6 SiO_2, Na_2O, 1.2 MgO	15'	356.3	42'6"

VISCOSITY AT 1150° C.

6 SiO_2, CaO, Na_2O	2'50"	340.2	8'20"
6 SiO_2, CaO, K_2O	4'15"	294.3	14'26"
6 SiO_2, CaO, ½Na_2O, ½K_2O	1'36"	322.6	4'58"
6 SiO_2, ½CaO, ½MgO, Na_2O	6'15"	345.1	18'6"
6 SiO_2, ½CaO, ½MgO, ½Na_2O, ½K_2O	5'15"	344.6	15'14"
6 SiO_2, ½CaO, ½MgO, K_2O	8'47"	323.6	27'8"
6 SiO_2, MgO,, Na_2O	9'22"	245	27'9"
6 SiO_2, ½ CaO, ½Al_2O_3, Na_2O	13'53"	365.5	29'42"
6 SiO_2, ½CaO, ½BaO, Na_2O	51"	342.1	2'29"
6 SiO_2, ½CaO, ½BaO, K_2O	2'	298.2	6'42"

These tables show clearly the influence of the composition of glass on its viscosity. The glass 6 SiO_2, CaO, Na_2O is



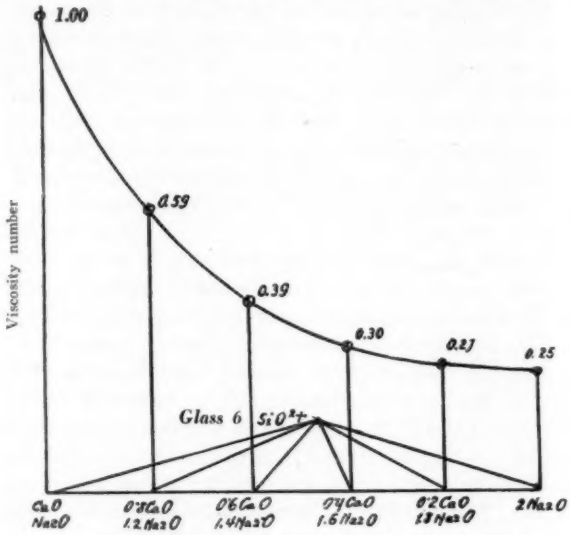
one of the most mobile. The substitution of sodium by potassium increases the viscosity of glass, gives it more body and makes the working easier. It gives a more plastic glass. The partial replacement of lime by magnesia decreases the mobility. This is especially so in magnesia glasses where the soda is replaced by potash. Barium oxide greatly reduces the viscosity of glass. The partial substitution of lime by alumina increases the viscosity considerably.

If one considers a series of soda lime glasses in which the gradual decrease of lime is accompanied by a proportional increase in the sodium oxide content, it is observed that the variation of the viscosity follows a regular law, as is shown in the accompanying charts:

Composition of glasses examined	Time necessary for the outflow of one gram at 1050° C	Viscosity Number
6 SiO_2, CaO, Na_2O	614"	1
6 SiO_2, 0.8 CaO, 1.2 Na_2O	367"	0.59
6 SiO_2, 0.6 CaO, 1.4 Na_2O	244"	0.39
6 SiO_2, 0.4 CaO, 1.6 Na_2O	188"	0.30
6 SiO_2, 0.2 CaO, 1.8 Na_2O	170"	0.27
6 SiO_2, Na_2O	158"	0.25

For each series of glasses, similar curves can be drawn, which will indicate for a certain temperature the variation of the viscosity with the composition.

By working at different temperatures it is also possible to



obtain the variation of the viscosity as a function of these temperatures and to draw the corresponding curves.

Testing of Fire Brick for Boilers

The Bureau of Standards has issued Technologic Paper No. 279 entitled: "Testing of fire clay brick with special reference to their use in coal-fired boiler settings." This publication contains the report of a study of brick used in the settings of coal-fired boilers. In the laboratory refractories were subjected to an endurance test, a reheating test, quenching tests, load tests, softening points were determined, and the brick analyzed chemically and petrographically. As a result of the field survey data were obtained covering the boiler rating and load factor, the actual life and mode of failure of the refractory in the several locations of the setting, the kind and quality of fuel used, the fusion point of the ash, and the type of stoker.

As a result of this work the qualifications of high-grade refractories for coal-fired boiler settings are believed to have been established. It was found that a close relation existed between data obtained in the endurance, reheating, quenching, and softening point tests, and that the behavior of brick in these tests depended to a remarkable extent on the chemical composition.

Vast Wealth Tied Up in Real Estate

More than half of the wealth of the United States is contained in the single item of real property, the land of the forty-eight States and the buildings which make up its cities, villages and farm communities.

The total wealth of the United States exclusive of the property owned by the Government itself is $310,274,476,476, according to the census lists.

Of this, real estate totals $174,231,456,000. This includes property of States and of smaller governmental divisions.

A Fallacy in Furnace Port Construction

By S. R. Scholes*

Many glass tank furnaces are still constructed with "tongue tiles" in the ports. In such a port, the producer gas flows under the tongue tile and the air above it, to a point within three feet of the inside of the jamb-wall of the furnace. The theory of this construction originally was (Siemens') that the gas, being lighter than air, would rise at the end of the tongue tile and mingle with the air. At the same time, a slope downward was given to the cover of the port, to deflect the stream of air and the flame itself, down toward the glass.

Let us examine producer gas, with respect to its specific gravity compared with air = 1. Assuming a typical producer gas, and multiplying the percentage of each component by its specific gravity, we arrive at the following calculation:

Gas	*Per Cent*	*Sp. Gr.*	*Product*
Carbon dioxide	5	1.53	7.65
Hydrogen	12	.069	.83
Ethylene	1	.97	.97
Carbon monoxide	24	.97	23.28
Methane	3	.554	1.66
Nitrogen	55	.97	53.35
	100		87.74

$\frac{87.74}{100} = .8774$, sp. gr. of the assumed gas, compared with air at the same temperature and pressure.

This shows that a typical producer gas is 87 per cent as dense as air, considering merely the gases found on analysis of a cold sample. It is well understood that tar-vapors exist in producer gas, not detected on analyzing because of their condensation in the collecting bottle; and these must increase appreciably the true specific gravity of the gas as delivered to the furnace.

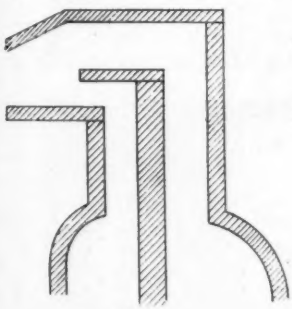


FIG. 1

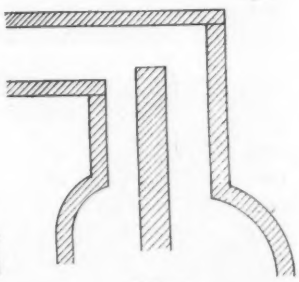


FIG. 2

We must next consider the effect of heat expansion on gas and air, affecting both alike. At a temperature of 1,600° F., a mass of gas or air occupies approximately four times its volume at the freezing point of water, the standard temperature for measurement of volumes, specific gravities, etc. With a rise of temperature of 300° more, a further expansion of 1/5 its original (cold) volume would take place. That is to say, 1 cubic foot of cold air entering the valve has become 4 cu. ft. at 1,600°. At 1,900°, it becomes 4.6 cubic feet and its sp. gr. has gone down to .217. The specific gravity of the above producer gas at 1,600° is $\frac{.877}{4}$ or .219.

Therefore, if the air checkers of a furnace are run hotter than the gas checkers, as the best modern practice requires, a difference of only 300° will result in actually reversing densities, so that the air is specifically lighter than the gas! It is clear that the above argument holds for any temperature of pre-heating or regeneration, and 1,600° is merely chosen for example.

Figure 1 is a diagram showing a cross-section of a port with tongue-tile. The flame from such a port will have a thick, smoky character at the lower edge of the port mouth, clearing and becoming brighter higher up, while the upper third, or thereabouts, of the port opening shows no flame, but carries a stream of air across the tank above the fire.

The mixing of the gas and air is therefore very poor and incomplete. Often a long tongue of flame is carried over into the opposite checkers, before it encounters enough of the air for combustion. At the same time, the air may be actually in excess, and exercise the bad effects of excess air in cooling the checkers on the incoming side, while diluting the fire-gases so as to make the entire furnace less efficient.

Heating a reverberatory furnace such as a glass tank requires a high temperature flame, best obtained by proper pre-heating and complete mixing. Failure of either of these conditions results in a flame of lower temperature, necessitating the burning of more fuel to maintain full heat.

A better port construction, although not ideal, is illustrated in Fig. 2. Here the gas rises directly into the stream of air traveling horizontally across it, finding much better chance for mixing with its quota of air before entering the furnace proper.

Objection has been raised to this type of port on the ground that combustion starting so far back in the port would generate so much heat there as to cause failure of the port by burning it out. This fear seems scarcely warranted, because the character of the flame of producer gas is such that its full effect cannot be reached in anything like the first four or five feet of its length.

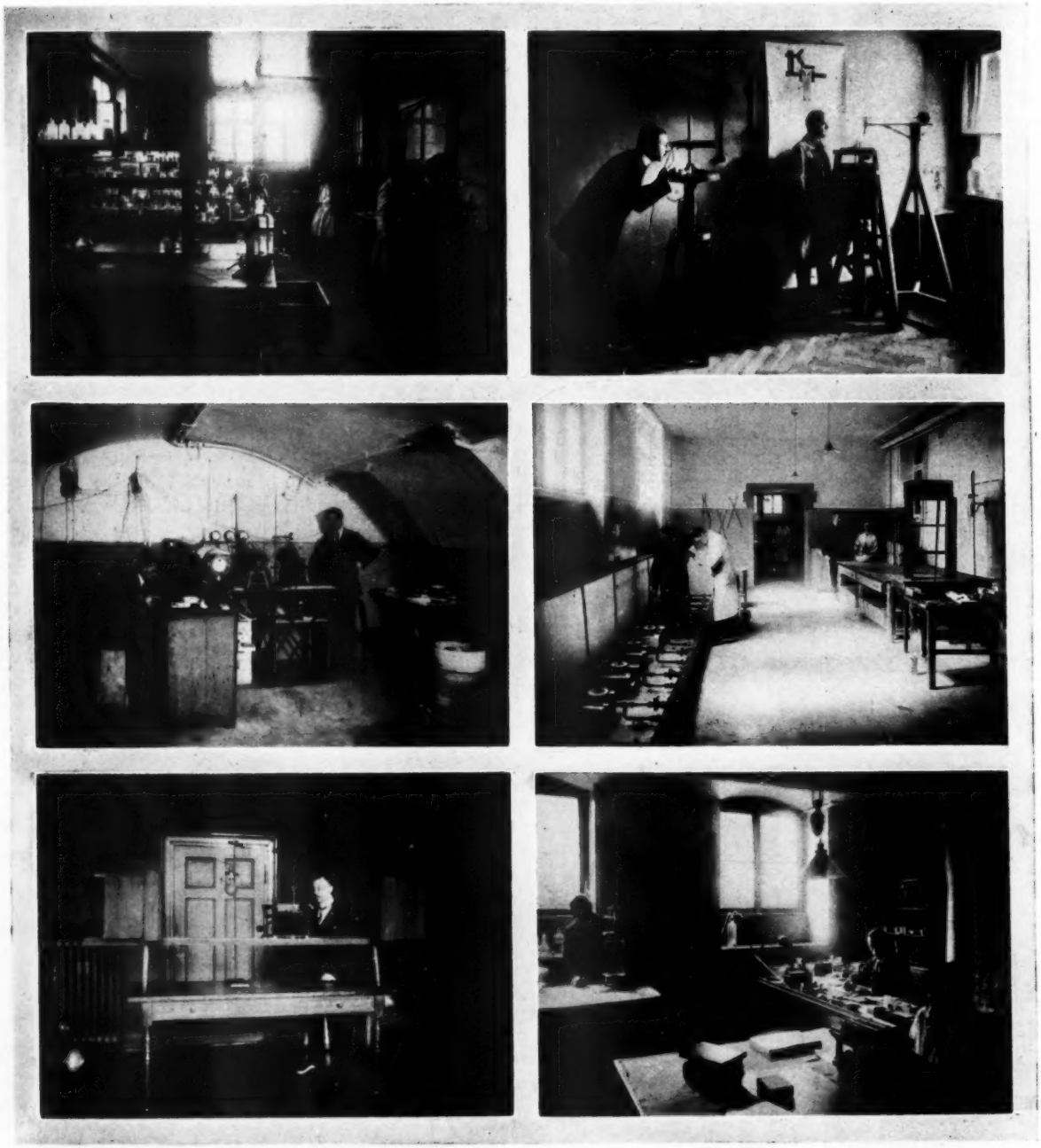
Moreover, experience shows that these simple ports actually outlast the ports with tongue-tiles, because the tongue-tile itself, heated on both sides by the tip of the long flame referred to, is likely to be short-lived.

No doubt the tongue-tile construction was satisfactory when furnaces were run at a lower temperature. But the final 100° of temperatures now in use can only be gained and held by good combustion. This requires, it may be repeated, thorough mixing of gas and air, and no mistaken theory of density relations should be allowed to perpetuate ineffective port design.

The ports of a tank must be considered as large burners. In firing natural gas and other clean gases of high calorific power, special attention is paid to adequate mixing with air. Surely just as much care must be taken in this matter, if the leaner producer gas is to be burned with the best results.

*The Federal Glass Co., Columbus, Ohio.

Views of the Glass Research Laboratory of the Technical University of Karlsruhe, in Baden, Germany



UPPER LEFT: ANALYTICAL LABORATORY. MIDDLE LEFT: ELECTRIC FURNACE ROOM. LOWER LEFT: PHOTOMETER ROOM. UPPER RIGHT: PHYSICAL LABORATORY. MIDDLE RIGHT: GLASS MELTING ROOM. LOWER RIGHT: OFFICE OF FIRST ASSISTANT.

The Glass Research Laboratory of the Technical University of Karlsruhe was formally opened on February 28, 1925, in the presence of official representatives of the Baden Government, numerous delegates from German universities and representative members of the German glass industry.

The establishment of a chair of glass technology and of the glass research laboratory at the University has been made possible through the generosity of Messrs. Louis Stoesz, Putzler Bros., Max Gundelach and Gundelach Bros. and other glass manufacturers.

The institution is under the direction of the well-known authority on glass technology, Dr. Eberhard Zschimmer, formerly of the firm of Schott & Genossen, Jena. Dr. Zschimmer received a call to the University in February, 1922, when he was appointed Professor for Theory of the Art of Glass Making.

* Photographs by courtesy of *Sprechsaal*.

A Classified List of the United States Patents on Glass

A Valuable Compilation, the Use of Which Will Relieve the Searcher of Glass Patent Records of Innumerable Hours of Wearisome Labor

By T. E. Kirch*

There are now more than a million and a half patents issued in the United States. The mention of a number like that is sufficient to discourage the average man from any attempt to acquaint himself with what the patent literature contains which would be of interest to him. The patent office is a tremendous storehouse of ideas and the progressive manager of the future will have to have a first hand knowledge of what it contains along his line of work. I have tried to simplify the matter of obtaining this information in the case of the glass industry.

These million and a half patents have been divided into 289 classes by the patent office. Class 49 is Glass. The present method of searching for patents is to go to the Yearly Index and find Glass in the Alphabetical List of Subjects of Invention. The patent numbers found there can then be examined in the Patent Office Gazette or in the full specifications. This is a long and tedious method as there are 53 volumes of Index and 330 volumes of Gazette including all of 1924, which is the scope of this classification.

The use of the printed Classification below will considerably reduce this labor. For example: You are interested in the manufacturing of incandescent lamps. Refer to the Manual for the Classification of Patents, part of which I have appropriated for an index. It divides the subject Glass into 93 sub-classes. Sub-classes 2 and 78 will be found to be Incandescent Lamp Making. Under these numbers and headings in the Classification itself will be found 140 patent numbers which deal with this division of the glass industry. These numbers can be examined in the abstracts in the Gazette or in the Specifications, which are available in the public libraries of the larger cities, or the patents themselves can be ordered from the Patent Office at Washington at ten cents each.

Again: suppose you are interested in pot furnaces. The Manual for the Classification of Patents shows sub-class 59 to be Pot Furnaces. Under this number in the Classification will be found the numbers of 62 patents on this subject. Surely any company would be willing to spend $6.20 to know what has been patented on this subject.

If you wish to examine these patents in the Gazette the writer's "Numerical Index to United States Patents"[1] is a great aid. It will refer you to the exact volume of the Gazette or furnish you with the month and year of issue of any patent.

This Classification places the entire patent literature on the subject of glass at the disposal of the glass industry. There is no longer any reason for only the larger firms who can afford to hire experts to have the monopoly on this information. It is now and always has been available to the small and the large establishments, if they want it.

Considerable care was taken in checking this list to make it as accurate as possible. It is probable that errors and omissions have been made. We would be glad to know of them so that corrections can be published.

*Glass Engineer, Pittsburgh, Pa.

[1]To be published in a subsequent issue.

Manual of Classification of Subjects of Invention of the United States Patent Office
Revised Classification of 1920

Class 49. Glass

Sub-class

1. Combined machines—
2. Incandescent lamp making
3. Sheet and plate making—
4. Flattening and annealing
5. Charging, cutting and annealing
6. Shaping and cutting
7. Reheating and reshaping
8. Pressing and blowing—
9. In separate molds—
10. Internal press-mold
11. Descending mold-bottom
12. Casting and blowing—
13. In separate molds
14. Miscellaneous
15. Tools
16. Pin-heading
17. Drawing—
17.1 Cylinders
18. Blowing—
19. Traveling molds
20. Manipulating blow iron
21. Tools
22. Reshaping—
23. Neck-forming—
24. Tools—
25. Divided mandrel
26. Crimping
27. Spreading and flaring
28. Perforating
29. Molding—
30. Curved pipes and tubes
31. Vertical pipes and tubes
32. Wire glass
33. Rolling—
34. Bed and roller
35. Presses—
36. Screw-threading
37. Traveling molds
38. Fluid operated
39. Casting
40. Mold-coolers
41. Mold supports and carriers—
42. Mold-separating devices—
43. Drawing core
44. Flattening
45. Annealing—
46. Furnaces—
47. Conveying
48. Cutting hard glass—
50. Heat-appliances
52. Tools
53. Heating apparatus—
54. Tank-furnaces—
55. Delivering
56. Separate gathering-pools
57. Reheating-furnaces—
58. Work-manipulating
59. Pot-furnaces
60. Melting pots
61. Floats
62. Gathering and ladling
63. Batch-mixers
64. Snaps and sockets
65. Molds—
66. Uniting parts
67. Bending
68. Cooling and heating
69. Blowing—
70. Labeling
71. Vented
72. Pressing—
73. Laterally-separable sides
74. Helically separable
75. Clamping
76. Cores and plungers
77. Processes—
77.5 Slag
78. Incandescent lamp making
78.1 Quartz glass
79. Combined—
80. Molding and blowing
81. Uniting parts—
82. Glass to glass—
82.1 Bi-focal lenses
83. Blowing
83.1 Drawing
84. Reshaping
85. Molding—
86. Wire-glass
87. Sheets and plates
88. Heat-developed coloring
89. Annealing
92. Structure

Note:—Sub-class 49 was eliminated by the re-classification of 1920, see Class 88, sub-class 57.

Sub-class 51 was eliminated by the re-classification of 1920.

Sub-class 90 was eliminated by the reclassification of 1920, see Class 106, Sub-class 36.1.

Sub-class 91 was eliminated by the re-classification of 1920, see Class 106.

Classified List of United States Patents on Glass

Class 49 Glass

1. Combined Machines

Re. 9,900	Re. 12,049	23,317	77,834	191,524	224,896	245,248
263,023	364,211	419,441	463,646	482,144	493,808	499,082
500,480	517,016	533,623	539,168	542,446	548,525	559,361
596,356	596,424	602,677	614,841	617,921	617,923	622,457
626,859	645,787	645,788	660,697	666,422	678,287	709,724
709,797	714,558	730,665	741,753	765,119	771,763	810,462
820,478	836,297	932,765	961,602	964,348	1,007,156	1,040,280
1,048,456	1,091,828	1,103,886	1,113,933	1,152,867	1,164,311	1,156,858
1,174,217	1,174,261	1,184,462	1,191,317	1,195,588	1,203,099	1,208,978
1,232,495	1,256,541	1,298,463	1,314,212	1,352,396	1,382,994	1,384,967
1,406,045	1,408,000	1,436,197	1,440,408	1,461,416	1,462,522	1,471,725
1,493,044	1,503,962					

2. Incandescent Lamp Making

289,837	537,493	565,576	568,142	677,548	715,898	729,237
734,734	741,822	764,844	766,321	770,221	774,403	793,211
796,470	829,538	833,131	833,196	842,191	843,750	846,823
856,972	856,974	860,977	869,428	871,097	871,160	877,013
882,190	883,875	884,568	885,039	918,669	919,851	921,979
928,670	936,153	955,442	968,524	1,004,071	1,004,072	1,011,523
1,011,586	1,019,457	1,101,168	1,104,295	1,117,059	1,119,642	1,128,120
1,132,277	1,151,273	1,210,237	1,210,238	1,220,836	1,315,783	1,326,121
1,338,500	1,352,396	1,368,552	1,404,268	1,409,339	1,409,847	1,423,957
1,438,941	1,453,594	1,472,456	1,487,288	1,492,602	1,496,078	

3. Sheet and Plate Making

8,994	262,495	305,716	367,565	373,695	396,512	
431,489	433,410	434,400	444,560	463,642	506,216	517,460
527,754	531,732	538,393	560,759	616,245	618,861	635,041
635,340	661,024	667,007	679,292	690,199	696,007	696,008
711,287	720,517	722,687	722,688	726,530	753,069	754,752
754,426	766,275	770,832	775,204	786,476	787,437	789,911
797,346	800,402	805,064	817,063	820,205	841,752	855,185
868,578	887,623	915,879	936,664	955,066	958,613	972,166
972,433	999,015	1,101,392	1,133,751	1,168,303	1,230,424	1,247,617
1,248,819	1,255,450	1,261,367	1,261,939	1,273,310	1,274,916	1,280,139
1,282,254	1,283,538	1,305,288	1,307,357	1,310,451	1,334,569	1,341,262
1,345,628	1,345,629	1,346,571	1,347,202	1,363,450	1,381,591	1,396,330
1,402,145	1,407,036	1,413,766	1,436,421	1,460,488	1,466,421	1,471,189
1,469,379	1,474,019	1,478,554	1,479,206	1,482,106	1,485,500	1,492,975
1,511,889	1,515,450	1,519,259				

4. Flattening and Annealing

Coffin, W.		Oct. 1, 1830		Adams, J. J.	April 21,	1832
44 Re.	2,820	3,035	3,081	35,314	64,244	112,322
144,946	156,776	229,976	258,156	298,332	303,195	314,524
330,172	333,331	336,855	342,670	474,983	478,328	492,765
505,418	508,934	510,784	526,528	543,207	694,711	1,120,486

5. Charging, Cutting and Molding

Re.13,723	549,404	592,784	592,908	593,857	605,648	617,818
620,828	643,253	649,260	658,173	669,524	671,757	672,987
674,248	684,669	687,596	714,396	723,983	729,963	766,768
781,539	781,540	787,526	792,581	794,891	797,247	810,167
820,479	847,696	852,097	852,932	859,117	870,664	872,194
873,670	877,091	880,482	893,500	901,199	901,881	904,975
914,823	919,120	923,261	940,165	966,440	971,587	979,045
1,002,397	1,011,023	1,015,537	1,015,538	1,017,870	1,037,364	1,037,365
1,047,731	1,078,965	1,100,345	1,116,340	1,125,895	1,133,244	1,147,539
1,147,892	1,154,894	1,169,953	1,177,289	1,177,589	1,182,811	1,185,687
1,189,811	1,191,868	1,198,979	1,199,665	1,209,635	1,212,135	1,217,494
1,229,060	1,245,262	1,251,156	1,256,979	1,260,637	1,263,982	1,264,085
1,271,961	1,282,487	1,292,940	1,297,706	1,297,981	1,308,095	1,312,876
1,314,691	1,317,176	1,322,726	1,326,235	1,328,273	1,331,512	1,331,528
1,331,536	1,332,143	1,338,604	1,348,365	1,350,375	1,356,174	1,364,514
1,371,085	1,373,202	1,374,966	1,375,336	1,379,593	1,385,428	1,405,204
1,413,742	1,416,725	1,439,384	1,438,665	1,446,670	1,445,345	1,451,707
1,458,454	1,458,167	1,462,491	1,466,367	1,470,023	1,482,762	1,484,907
1,484,952	1,490,182	1,491,369	1,494,438	1,497,929	1,499,334	1,499,523
	1,500,879	1,512,372	1,514,526	1,515,885		

6. Shaping and Cutting

15,548	196,326	205,781	214,274	218,010	228,495	247,515
346,181	364,840	415,802	424,524	457,867	493,794	541,851
555,164	595,017	611,042	627,092	642,928	650,780	672,281
696,254	733,013	737,791	742,420	753,695	771,421	787,588
793,797	832,860	1,028,129	1,048,465	1,513,756		

7. Reheating and Reshaping

22,063	44,734	220,344	238,090	317,269	411,132	418,235
439,196	439,197	439,198	477,477	507,626	557,105	592,645
608,427	614,840	614,935	617,922	676,551	713,280	741,823
761,139	761,178	760,644	778,209	786,259	805,876	805,877
828,318	842,426	866,347	884,478	954,901	959,930	982,212
1,009,418	1,024,116	1,040,902	1,055,402	1,107,935	1,117,060	1,124,386
1,156,971	1,159,853	1,165,884	1,199,482	1,199,483	1,242,837	1,248,582
1,262,567	1,264,355	1,304,691	1,308,408	1,313,205	1,322,778	1,322,779
1,330,707	1,332,725	1,335,733	1,338,499	1,338,941	1,342,821	1,343,179
1,390,626	1,437,239	1,439,698	1,443,470	1,455,056	1,461,227	1,471,010
1,482,455	1,489,729	1,489,836	1,489,837			

8. Pressing and Blowing

428,712	662,203	672,716	677,530	685,103	704,761	726,112
743,338	744,006	744,009	777,261	796,634	814,191	825,082
893,180	894,082	923,898	996,365	1,134,200	1,147,695	1,148,214
1,177,135	1,199,695	1,236,606	1,272,861	1,292,243	1,325,331	

9. In Separate Molds

Re.11,890	416,376	461,489	522,671	567,236	585,469	608,022
609,704	610,515	616,664	617,947	617,948	617,949	617,950
619,694	626,464	629,844	630,284	644,395	650,722	653,412
653,523	654,451	679,664	687,595	687,597	692,813	693,130
617,947	697,915	703,599	705,813	711,159	711,800	711,962
722,634	731,885	733,806	735,764	738,657	744,008	757,356
759,989	767,807	767,811	767,935	773,509	779,159	784,744
790,505	805,027	806,669	810,031	815,037	822,623	828,180
829,210	854,236	855,344	855,345	863,946	815,960	933,939
944,053	949,380	987,671	988,165	1,013,452	1,021,043	1,043,129
1,046,185	1,056,579	1,065,499	1,066,654	1,072,553	1,148,214	1,148,701
1,149,857	1,177,613	1,182,448	1,188,559	1,193,182	1,197,837	1,212,135
1,217,102	1,232,353	1,241,516	1,259,281	1,292,051	1,315,983	1,329,253
1,331,472	1,337,723	1,373,272	1,394,092	1,141,910	1,431,436	1,437,178
1,462,652	1,502,560		1,502,561	1,515,962	1,521,375	

10. Internal Press Molds

416,389	436,750	531,609	567,071	582,950	584,665	598,221
604,907	647,276	650,655	666,595	675,166	682,906	687,136
733,805	736,708	738,845	742,662	744,010	775,709	777,876
779,089	779,602	781,685	786,659	787,050	792,500	806,119
808,874	809,902	817,576	817,745	820,403	820,404	869,538
922,071	937,626	950,941	975,758	975,759	994,710	1,297,412
1,393,118						

11. Descending Mold Bottom

139,993	178,819	447,451	447,452	453,795	469,053	484,131
562,154	581,083	594,646	716,478	719,710	778,787	844,942
910,120	1,061,404	1,087,287	1,369,679	1,425,124		

12. Casting and Blowing

403,025	468,140	493,984	546,931	641,048	645,375	646,133
664,102	687,582	701,188	725,498	742,505	745,391	766,932
767,391	768,034	768,589	769,149	784,439	796,529	825,160
825,161	865,517	956,505	1,007,252	1,020,222	1,035,390	1,039,709
1,143,423	1,328,864					

13. In Separate Molds

403,027	403,717	403,718	453,977	503,220	523,607	529,693
568,287	610,931	628,313	656,286	665,055	700,101	704,055
711,818	723,933	724,388	732,902	791,240	795,304	804,576
814,800	833,295	847,666	927,913	933,590	944,091	957,349
964,198	978,228	987,714	994,422	994,735	998,824	1,003,471
1,004,020	1,046,867	1,132,071	1,133,708	1,139,545	1,213,291	1,234,406
1,325,388	1,404,206					

14. Miscellaneous

Re.15,600	99,160	119,451	124,378	176,495	188,763	206,386
207,263	210,326	508,697	509,195	515,838	528,240	531,526
624,346	667,263	720,665	731,667	735,949	743,824	765,570
769,917	790,076	814,774	815,222	818,134	852,590	923,218
934,998	944,555	988,636	992,230	1,003,406	1,056,632	1,063,108
1,085,871	1,087,283	1,105,610	1,114,098	1,116,081	1,124,475	1,126,365
1,130,919	1,132,618	1,134,200	1,134,763	1,143,104	1,143,109	1,154,895
1,163,605	1,165,962	1,174,719	1,176,392	1,180,498	1,187,276	1,199,379
1,211,611	1,234,010	1,250,562	1,263,668	1,272,971	1,275,629	1,300,181
1,319,098	1,326,460	1,328,799	1,329,841	1,331,847	1,336,028	1,336,317
1,346,528	1,357,231	1,361,855	1,379,594	1,391,527	1,398,670	1,406,400
1,408,939	1,414,008	1,413,183	1,414,547	1,421,810	1,439,368	1,444,327
1,451,957	1,453,315	1,458,455	1,458,456	1,465,022	1,470,988	1,473,587
1,478,126	1,479,511	1,482,272	1,503,188	1,508,468	1,511,550	1,518,852

15. Tools

9,533	11,562	51,386	115,569	168,371	170,798	191,793
275,130	352,672	415,625	434,982	498,835	545,826	629,555
807,268	877,105	991,623	1,162,815	1,217,142	1,306,993	1,375,318
1,457,491						

16. Pin Heading

601,062	685,948	723,392	1,353,294			

17. Drawing

Re.13,804	Re.14,794	Re.15,452	245,209	285,888	463,643	463,644
713,758	717,378	743,898	758,544	758,560	758,988	759,329
763,633	787,638	810,035	811,952	813,291	820,971	821,724
821,785	821,786	822,446	823,581	832,561	832,842	834,894
836,439	837,212	837,265	837,821	837,822	840,433	842,399
844,115	847,674	849,531	852,590	860,528	846,665	867,948
876,267	885,896	891,924	896,511	901,800	902,207	908,259
914,117	921,747	922,973	996,665	940,675	941,866	946,179
952,354	953,973	954,457	956,449	963,276	966,652	966,653
967,966	970,182	970,633	972,613	973,002	979,935	988,454
991,642	1,015,522	1,016,933	1,030,618	1,031,883	1,032,238	1,032,239
1,032,592	1,045,901	1,069,019	1,087,154	1,118,579	1,118,665	1,119,329
1,119,535	1,122,692	1,128,448	1,136,816	1,138,870	1,141,932	1,156,273
1,160,692	1,161,912	1,161,913	1,184,996	1,198,044	1,204,496	1,220,906
1,224,032	1,240,185	1,248,809	1,251,932	1,267,849	1,272,652	1,273,345
1,274,385	1,274,616	1,277,511	1,278,046	1,307,943	1,319,175	1,320,091
1,324,965	1,325,265	1,326,241	1,328,268	1,331,796	1,338,261	1,339,229
1,342,533	1,349,200	1,349,201	1,355,449	1,358,390	1,359,200	1,362,378
1,363,622	1,386,724	1,391,405	1,391,406	1,393,081	1,394,809	1,398,109
1,396,216	1,397,326	1,399,547	1,411,079	1,413,238	1,420,868	1,422,036
1,423,195	1,424,155	1,425,218	1,425,225	1,427,014	1,428,533	1,435,956
1,435,958	1,439,855	1,444,038	1,444,039	1,447,647	1,447,654	1,447,661
1,447,702	1,449,038	1,450,590	1,453,842	1,460,582	1,461,603	1,462,495
1,463,251	1,463,273	1,463,582	1,466,457	1,466,460	1,469,380	1,469,383
1,483,336	1,484,339	1,489,822	1,489,823	1,489,852	1,489,875	1,489,876
1,492,942	1,500,381	1,503,608	1,508,049	1,509,183	1,511,551	1,514,338
1,514,953	1,515,021	1,515,174	1,515,625	1,518,734	1,519,247	

17.1 Cylinders

Re.11,702	Re.12,308	Re.12,427	Re.14,911	Re.15,143	13,245	13,411
267,962	463,645	593,581	614,615	696,467	702,013	702,015
702,017	737,470	749,680	750,538	759,159	763,353	766,183
772,509	772,510	788,143	788,144	792,590	804,173	804,533
805,053	805,054	805,055	805,056	810,218	812,894	813,247
813,248	813,290	821,478	824,750	829,991	834,165	835,061
839,421	846,102	846,316	847,027	850,833	863,200	871,687
886,618	894,026	901,170	913,190	914,588	915,282	920,107
926,501	935,663	938,305	941,148	946,921	951,222	953,133
962,925	963,888	965,205	969,385	972,614	972,615	972,687
973,934	979,137	1,000,671	1,007,503	1,007,571	1,008,464	1,008,465
1,018,643	1,020,858	1,034,445	1,034,446	1,034,447	1,034,448	1,034,985
1,038,177	1,042,956	1,057,056	1,058,065	1,071,727	1,073,613	1,114,897
1,114,898	1,115,932	1,119,007	1,120,512	1,122,477	1,123,684	1,131,953
1,133,752	1,133,764	1,134,192	1,138,885	1,140,314	1,141,497	1,161,911
1,162,337	1,163,487	1,163,969	1,164,766	1,165,961		1,166,025
1,166,125	1,168,960	1,170,257	1,170,464	1,176,498	1,179,250	1,180,875
1,187,277	1,195,002	1,197,558	1,213,285	1,219,709	1,224,032	1,225,591
1,236,241	1,239,024	1,242,055	1,243,023	1,256,260	1,291,921	1,299,019
1,307,381	1,308,278	1,309,942	1,311,137	1,311,804	1,314,638	1,318,190
1,321,810	1,324,229	1,326,296	1,326,571	1,328,673	1,329,065	1,330,097
1,335,653	1,336,056	1,343,186	1,347,131	1,351,833	1,354,391	1,361,635
1,375,818	1,386,441	1,398,019	1,415,133	1,425,746		1,458,518
1,460,285	1,472,291	1,480,188	1,491,749	1,492,549	1,516,136	

18. Blowing

Re.14,468	89,127	180,451	280,397	403,716	437,823	493,867
548,587	550,278	566,469	567,739	582,949	594,343	594,494
608,754	620,567	620,568	620,642	621,794	621,795	625,701
632,486	635,392	635,393	644,372	659,290	659,291	666,125
668,858	698,818	740,455	752,597	822,220	825,423	828,484
858,379	858,592	929,456	936,822	998,921	1,066,270	1,098,724
1,123,524	1,123,525	1,124,699	1,137,304	1,156,858	1,156,868	1,209,472
1,232,703	1,235,420	1,294,319	1,335,533			

19. Traveling Molds

Re.11,668	Re.11,825	534,840	548,588		548,600	548,605
557,298	570,881	576,074	580,349	581,158	582,158	584,755
604,908	605,133	610,589	611,157	615,608	625,513	631,624
635,344	636,590	657,097	659,289	659,726	671,100	698,817
765,451	813,289	862,728	892,089	920,622	922,342	929,330
1,029,779	1,052,902	1,070,530	1,080,168	1,155,809	1,156,058	1,163,982
1,174,919	1,187,889	1,255,317	1,428,855			

20. Manipulating Blow Iron

134,926	161,861	223,726	255,503	292,730	458,190	644,474
656,322	686,850	703,325	1,038,335	1,106,140	1,124,698	1,124,700
1,124,701	1,124,702	1,148,212	1,148,216	1,157,653	1,221,332	1,248,664
1,254,904	1,315,130	1,331,772	1,410,803	1,410,857	1,497,332	

21. Tools

142,845	233,550	268,162	282,870	289,838	373,132	381,887
386,302	444,160	503,676	646,037	646,038	733,130	747,049
900,914	963,247	976,796	1,123,523	1,309,166		

22. Resbaping

Stanford, J., Oct. 17, 1831

215,761	240,022	277,414	283,625	363,580	527,924	530,820
558,536	558,537	575,125	579,127	599,816	599,822	601,898
613,319	620,693	650,433	663,023	759,165	1,046,996	1,325,785
1,436,825	1,436,878					

23. Neck Forming

166,390	187,725	195,411	213,605	214,345	226,889	306,670
314,975	346,116	348,797	384,290	398,280	400,555	400,556
401,670	404,311	414,451	416,559	423,482	426,497	428,214
512,137	631,329	631,582	631,583	631,584	631,585	631,586
631,587	631,588	631,589	631,590	645,189	646,874	647,352
648,272	654,737	654,768	668,223	668,928	674,519	760,258
784,798	791,459	830,408	833,823	891,259	916,598	920,550
1,000,256	1,006,383	1,130,845	1,168,517	1,188,669	1,226,700	1,229,028

24. Tools

13,402	15,788	23,623	23,640	27,333	30,106	56,263
68,416	102,899	104,390	109,825	110,243	125,739	127,530
130,207	154,109	240,927	395,220	413,656	442,258	457,035
480,774	491,069	509,214	509,525	512,409	532,378	534,873
563,207	606,200	666,939	680,306	681,454	692,957	714,304
744,681	793,213	818,691	840,565	845,235	848,095	1,036,295
1,092,569						

25. Divided Mandrel

Re.13,339	29,739	37,142	55,988	79,434	93,039	153,338
172,275	175,777	183,267	192,509	265,726	295,848	313,346
316,832	333,733	341,317	345,194	361,774	369,890	382,929
400,898	443,728	463,575	500,960	511,033	532,191	557,451
568,772	586,532	611,631	646,847	646,848	646,849	646,850
646,851	648,197	706,344	775,206	947,632	1,003,717	

26. Crimping

Re.8,677	Re.8,716	170,283	170,431	170,616	173,801	176,449
188,626	201,589	209,425	212,421	212,850	214,276	232,492
285,345	327,406	336,666	344,585	358,724	369,296	406,693
416,099	437,154	438,019	440,494	512,078	566,803	608,905
644,536	677,161	909,640	1,478,261			

27. Spreading and Flairing

71,838	84,040	119,222	175,851	193,317	202,631	212,932
214,054	214,150	214,273	222,788	222,789	222,790	230,543
232,625	249,751	280,546	285,719	334,126	345,979	401,199
528,081	566,514	612,835	653,586	697,521	792,780	1,013,427

28. Perforating

168,149	199,030	320,505	547,742	756,935	810,460	810,464
810,465	810,474	852,129				

29. Molding

122,015	151,352	406,165	433,062	443,033	462,083	507,400
588,319	613,096	704,488	742,028	836,991	840,056	841,511
1,190,145	1,266,401	1,301,378	1,303,452	1,507,055		

30. Curved Pipes and Tubes

198,741	438,806	476,772

31. Vertical Pipes and Tubes

217,789	238,796	417,306	438,807	459,490	494,951	600,463
624,480	624,481	647,866	655,235			

32. Wire Glass

Re.12,443	483,020	510,716	510,823	516,221	516,223	531,570
534,391	546,196	555,351	561,920	574,458	605,754	608,096
610,586	610,593	649,647	653,850	656,296	681,786	766,429
791,216	791,217	792,803	800,131	800,132	805,608	805,609
805,610	805,657	805,659	810,446	810,447	810,786	812,994
814,515	823,357	823,112	827,427	827,686	835,511	839,573
839,574	839,575	844,587	846,771	847,878	849,459	856,661
858,366	868,713	876,307	876,653	881,791	892,044	901,725
902,849	906,952	915,805	936,663	936,880	940,834	940,835
940,836	940,837	940,838	940,839	940,840	940,841	940,842
940,843	940,844	940,845	940,846	941,842	944,861	945,054
945,314	945,315	945,316	945,317	945,318	952,126	954,956
957,594	959,537	959,102	959,434	966,819	976,125	1,003,093
1,064,146	1,113,208	1,135,370	1,135,937	1,144,976	1,149,117	1,169,759
1,170,008	1,217,614	1,232,107	1,323,389	1,341,547	1,397,149	1,466,125

33. Rolling

83,841	259,203	326,764	425,348	488,144	508,748	522,961
653,238	661,893	671,175	697,229	706,550	735,048	742,899
747,914	802,495	818,209	839,168	1,164,718	1,465,507	1,479,295
1,519,244	1,519,314					

34. Bed and Roller

175,419	346,695	359,128	362,698	370,177	370,178	396,535
424,049	437,028	462,528	474,484	487,803	510,080	510,338
527,476	529,157	547,630	602,447	666,717	673,837	679,705
681,787	695,281	695,282	710,032	716,086	734,216	760,667
760,668	789,397	807,630	813,675	813,794	814,471	818,210
827,679	838,889	862,503	879,491	907,656	945,319	968,178
1,175,116	1,179,544	1,184,144	1,197,184	1,207,643	1,207,867	1,248,478
1,297,566	1,313,071	1,343,014	1,366,786	1,375,014	1,382,608	1,392,626
1,398,046	1,466,621	1,513,731				

35. Presses

Re.5,517	4,297	10,470	39,698	46,330	52,584	57,296
61,233	69,325	69,426	79,635	91,132	94,863	102,070
117,785	124,364	130,039	135,292	138,750	162,233	179,673
189,351	207,327	214,879	215,516	220,822	224,433	227,103
227,608	230,534	297,590	300,381	301,426	346,737	353,461
418,881	424,331	442,330	442,890	471,516	519,113	543,154
547,705	561,056	586,188	592,262	596,652	598,930	612,465
614,303	618,178	618,560	624,389	628,157	656,505	670,438
674,378	690,119	726,088	767,310	773,247	790,715	804,069
805,335	815,180	830,160	838,875	843,849	844,600	856,067
859,906	861,379	894,040	904,795	909,014	943,858	947,204
952,272	962,519	1,011,647	1,027,567	1,093,363	1,115,785	1,149,987
1,372,164	1,396,759	1,457,216	1,482,263			

36. Screw Threading

Re.9,392	Re.13,661	53,816	99,145	103,555	116,926	128,280
129,036	129,095	131,153	162,894	242,825	266,565	270,526
275,298	275,984	281,740	282,989	283,321	303,936	310,484
419,875	532,973	542,565	596,651	596,682	646,948	646,949
686,285	723,589	739,666	743,268	761,326	767,515	773,768
809,969	817,835	820,477	835,235	835,236	835,245	837,409
840,994	849,461	857,803	859,306	859,307		877,981
880,343	902,865	909,595	937,137	961,944	1,049,594	1,136,275
1,137,000	1,193,787	1,334,647	1,334,648	1,406,722	1,453,759	

37. Traveling Molds

Re.4,571	114,569	134,070	134,171	162,791	181,434	433,411
588,173	588,795	601,491	602,636	603,952	612,140	616,251
622,270	660,444	668,910	670,764	702,425	708,326	737,490
783,046	794,179	799,332	810,375	810,570	811,320	824,070
829,530	835,613	860,293	862,466	900,940	916,574	972,704
1,132,855	1,144,527	1,171,928	1,213,853	1,217,635	1,269,186	
1,291,952	1,292,033	1,316,550	1,329,624	1,331,792	1,400,621	1,471,608

38. Fluid Operated

42,143	291,265	458,191	528,080	530,825	544,128	553,679
608,204	776,600	791,410	805,066	941,935	998,673	1,030,252
1,130,918	1,130,920	1,326,765	1,340,366	1,343,987	1,453,277	1,466,867
1,501,868						

39. Casting

127,699	140,927	185,712	360,785	385,735	433,254	447,683
531,733	601,083	628,399	653,849	666,086	673,548	708,113
715,868	735,086	760,825	861,803	956,297	985,783	1,420,018
1,488,911						

40. Mold Coolers

71,216	79,738	79,786	325,724	443,403	482,526	489,543
498,116	501,077	523,062	526,948	560,974	570,735	594,445
601,092	602,399	611,612	628,543	818,705	994,806	1,300,066

41. Mold Supports and Carriers

79,893	91,119	125,165	129,709	148,859	204,519	254,637
292,156	337,204	481,142	552,051	625,072	648,746	767,578
851,904	985,439	1,156,009	1,156,056	1,156,057	1,156,058	
1,461,271	1,494,042	1,499,524	1,499,525	1,499,526		

42. Mold Separating Devices

54,617	79,660	109,370	110,056	129,679	138,323	179,340
275,562	337,764	405,863	490,908	490,909	532,702	534,872
615,088	624,920	682,212	686,517	708,814	724,283	754,966
817,836	876,212	1,141,653	1,144,527	1,156,056	1,231,188	1,276,392

43. Drawing Core

Re.949	5,302	5,684	5,875	21,831	29,017	89,005
129,306	129,781	159,061	162,480	175,006	177,457	178,504
180,450	207,656	210,984	246,204	264,379	274,233	274,917
286,984	292,007	297,062	308,590	315,172	328,482	347,741
397,186	404,766	442,599	508,597	550,312	595,268	608,141
628,816	648,882	651,280	666,141	713,317	782,000	

44. Flattening

4,786	66,274	100,424	421,152	542,552	602,031	699,972
745,487	767,341	810,723	825,310	930,658	947,426	972,612
1,000,378	1,008,676	1,172,262	1,259,459	1,302,485	1,308,341	1,331,916
1,352,881	1,426,309	1,490,521				

45. Annealing

Re.972	157,717	161,380	169,783	172,303	178,797	207,924
208,207	226,934	248,674	251,573	254,272	381,387	506,719
555,048	564,526	564,568	574,389	625,801	925,674	1,083,409
1,266,625						

46. Furnaces

Re.15,603	38,930	188,745	305,675	338,880	430,937	437,027
477,920	480,230	505,716	529,316	716,405	737,909	762,742
805,069	842,427	891,693	952,517	1,125,154	1,132,459	1,178,549
1,196,152	1,268,217	1,342,233	1,351,323	1,361,604	1,426,310	1,484,521
1,500,609	1,517,890					

47. Conveying

43,278	48,761	71,571	164,632	206,109	270,929	293,879
295,398	313,347	317,808	365,813	412,073	431,884	569,279
577,542	636,078	690,200	700,427	707,343	718,257	722,073
785,506	786,565	790,716	805,070	813,194	844,705	900,281
922,941	1,070,509	1,071,331	1,148,474	1,142,025	1,152,969	1,165,585
1,178,549	1,178,550	1,195,087	1,206,807	1,214,217	1,226,633	1,232,798
1,243,777	1,247,890	1,257,150	1,257,441	1,281,426	1,281,713	1,289,208
1,295,564	1,296,818	1,313,222	1,316,160	1,322,735	1,334,453	1,338,240
1,388,992	1,341,031	1,372,420	1,386,240	1,416,575	1,439,305	1,447,633
1,453,116	1,469,461	1,473,897	1,474,058	1,514,385	1,520,408	

48. Cutting Hard Glass

295,603	423,579	427,002	545,767	610,588	627,288	653,265
662,924	744,244	856,973	876,102	916,504	916,518	921,828
926,470	1,006,995	1,024,983	1,046,723	1,086,394	1,117,736	1,123,336
1,124,784	1,135,652	1,174,719	1,220,201	1,307,209	1,312,306	1,315,799
1,328,219	1,377,320	1,460,286	1,462,030	1,480,875	1,511,016	

50. Heating Appliances

223,439	275,999	317,805	530,189	537,110	539,302	566,436
617,333	617,334	676,698	676,699	684,686	821,361	859,218
859,260	859,721	896,159	909,451	979,740	1,019,792	1,077,301
1,101,032	1,101,033	1,130,373	1,131,134	1,135,652	1,143,242	1,163,618
1,168,275	1,203,826	1,220,632	1,251,541	1,257,975	1,263,644	1,296,661
1,298,987	1,312,341	1,313,845	1,320,947	1,339,200	1,359,172	1,373,728
1,420,867	1,435,985	1,447,828	1,458,452	1,508,358		

52. Tools

Re.3,441	Re.8,478	30,722	30,973	33,188	44,331	47,645
56,231	64,157	85,396	91,150	101,111	111,269	126,302
166,684	167,575	188,058	207,809	229,228	231,225	308,709
310,914	316,430	333,235	363,563	365,057	365,190	408,055
433,537	442,062	454,233	457,732	464,997	467,500	476,626
482,601	483,778	505,211	506,406	513,965	515,298	520,247
526,444	529,957	535,222	557,200	565,493	616,825	672,312
682,966	702,277	742,179	766,827	778,023	781,211	805,309
820,092	847,633	849,149	862,049	863,316	887,604	911,342
915,447	915,818	922,361	934,487	936,674	942,152	950,273
989,603	996,385	998,254	999,668	1,005,637	1,028,870	1,102,843
1,129,374	1,134,292	1,134,307	1,161,889	1,169,579	1,169,714	1,170,588
1,201,515	1,221,076	1,232,366	1,308,260	1,347,972	1,375,958	1,419,310
1,482,206						

(To be continued)

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What Glass Technology Needs

That viscosity is the most important of the physical properties of glass is generally recognized. The introduction of modern automatic machinery has served to emphasize this fact and has been an incentive to numerous investigators to devote much study to the subject. It is appreciated by the great majority of glass makers that the problem of producing the maximum amount of high grade glassware at the lowest possible cost by the use of machines is largely a question of skill in the adjustment between the requirements of the machines and the fusibility, viscosity and workability of the metal.

The principal reason why American glass making machinery, that has been proven beyond doubt to be a success at home, has at times only given indifferent results in foreign countries, is due to failure to realize on the part of foreign users that control of the glass composition is of paramount importance.

The former lack of data regarding the effect of the composition on the viscosity and other physical properties of glass is rapidly being filled. From various countries have come contributions on this subject. What is needed now is the co-ordination of these various measurements into a comprehensive system so as to facilitate the use of this knowledge to the glass manufacturer. Much has been accomplished, it remains to express the results of the experimental work into laws.

We have progressed considerably from the time when the knowledge of glassmaking consisted largely in a compilation of batch formulas. We are no longer groping in the dark to correct glass defects. No longer do we make changes in a haphazard way. We have learned to think along chemical lines with regard to glass melting and furnace management. Although there remains much to be learned we are making great advances.

Glassmakers often refer to a batch of molten glass as "metal." The genius of man to sense analogies has seldom coined a more appropriate word. There is undoubtedly much resemblance between molten glass and molten metal. In spite of the enormous differences between the two, there is a great deal of similarity. Enough likeness exists between molten glass and molten metal to elucidate some of the properties which otherwise would be difficult to grasp.

Almost everyone who has ever studied electricity is familiar with the explanation of the laws of flow of electricity in conductors, by using the illustration of the flow of water through pipes. It would be difficult to understand the fundamental principles of electricity without the help of this analogy. The similarity between glass and metal is sufficiently great to aid in grasping an understanding of the influence of the composition of glass on its properties.

The effect of small amounts of phosphorus, sulphur, silicon, manganese, vanadium and other elements on the properties of steel are well known, and success in the art of metallurgy is wholly dependent upon controlling these factors. Is it not reasonable to affirm that success in the art of glass making depends on an equal amount of attention to similar details?

The day is not far distant when it will be possible to

predict with considerable accuracy the properties of glasses of almost any composition within reason, before they are made. This applies not only to viscosity but to many other physical properties, of interest to the manufacturer: expansivity, tensile strength, elasticity, heat conductivity, thermal resistance, hardness, and so forth. But in order to be really useful this knowledge when acquired must be made available to them who can profit by it. The great benefactors to industry are those who show us how to apply the fruits of investigation to actual practice.

Technical Consultation Service

QUESTION 78. BATCHES FOR TRANSPARENT YELLOW GLASS, COPPER, GOLD AND SELENIUM RUBY GLASSES. Do you know of any practical working formulas for transparent yellow glass? Also for copper, gold and selenium ruby glasses? Do each of these glasses have to be melted and handled in a peculiar way? Can the various ruby glasses be made so that the color comes direct as the glass comes from the pot without reheating?

ANSWER: Of all colored glasses, yellow glass is the most difficult to produce, in spite of the fact that quite a number of ways exist to make it. The following substances will give a yellow color to glass: antimony, cadmium sulphide, carbon, cerium oxide, ferric oxide, silver chloride, sulphur, uranium oxide.

The cheapest way to obtain a yellow color is by the use of carbon, as graphite, anthracite, charcoal, or by using charred organic substances. Of this class we suggest the following batches:

AMBER COLOR

Sand	100 lbs.
Soda ash	33 "
Limestone	18 "
Graphite	0.35 "

DARK YELLOW

Sand	100 lbs.
Soda ash	33 "
Limestone	14 "
Powdered coal	2½ "

Sawdust is also used and gives a better color than graphite or coal. The following batch is suggested:

Sand	100 lbs.
Soda ash	28 "
Potash	5 "
Burnt lime	13 "
Sawdust	1 "

A yellow color resembling sulphur is obtained with the following batches:

Sand	100 lbs.	Sand	100 lbs.
Potash	40 "	Potash	36 "
Burnt lime	13 "	Borax	2 "
Uranium oxide	1½ "	Burnt lime	16 "
Arsenic	½ "	Saltpeter	2 "
		Sodium uranate	1 "

Sand	100 lbs.
Soda ash	33 "
Burnt lime	14 "
Saltpeter	3 "
Uranium oxide	1 "
Arsenic	½ "

The following batch gives a golden yellow color:

Sand	100 lbs.
Potash	30 "
Saltpeter	30 "
Borax	10 "
Red lead	40 "
Tartaric acid	4 "
Common salt	2 "
Arsenic	1 "
Silver chloride	0.4 "

If a greenish yellow color is desired, a mixed color of chromium and silver is used. To obtain this mixed color a solution of potassium bichromate is added to a solution of silver nitrate. This gives a deep red precipitate which is filtered off, washed and dried. It can be substituted in the above formula for the silver chloride.

With regard to ruby glasses, they also are difficult to make and require experimentation before the desired results are obtained. They have to be reheated in order to develop the ruby color.

The following batches are suggested:

COPPER RUBY

Sand	100 lbs.
Potash	28 "
Soda ash	11 "
Limestone	18 "
Borax (calcined)	6 "
Cupric oxide	1 "
Stannous oxide	4 "
Witherite	19 "

The color of copper ruby is caused by colloidal copper. Some reducing agent such as potassium bitartrate or stannous oxide must be added to the batch. The batch should be melted at a fairly low temperature and oxidizing conditions should be avoided.

GOLD RUBY

Sand	100 lbs.
Saltpeter	33 "
Borax	32 "
Red lead	16 "
Antimony	1 "
Tartaric acid	0.85 "
Tin oxide	0.40 "
Gold	0.06 "

The gold is dissolved in a mixture of one part strong nitric acid and three parts strong hydrochloric acid (aqua regia). It is poured over a quantity of dry sand sufficient to absorb the liquid. This is allowed to dry and then mixed with the rest of the sand.

SELENIUM RUBY

I

Sand	100 lbs.
Potash	30 "
Soda ash	30 "
Zinc oxide	20 "
Cadmium sulphide	1.5 "
Selenium	1.5 "
Borax	1.5 "

II

Sand	100 lbs.
Soda ash	30 "
Slaked lime	28 "
Cadmium sulphide	1.5 "
Selenium	1.0 "

No. I is a soft working selenium ruby. No. II is recommended for a plate glass. The glass must be allowed to cool a sufficient length of time after gathering. The glass must be reheated for a period of from 1 to 5 minutes at a temperature of about 1,650 deg. F.

It is recommended to try out batches on a small scale and to carefully watch the results before filling up a pot. We do not assume responsibility for any of the batches given, as it is absolutely impossible to give all conditions which must be met in order to obtain a satisfactory result.—J. B. K.

Abrasive for Lens Grinding

Abrasive material which is used for fine lens grinding cannot be purchased. It is a product which is formed by the breaking up of the larger particles which are used in rough grinding, and collected in a large tank. The material must now pass through many operations in order to separate the finest and the coarsest grades, and the greatest care must be used so that not a single grain of coarse material or dirt remains in the flour-fine abrasive material.—*The Making of an Eye Glass Lens.*

CULLET PILE PHILOSOPHY

By SILICA SAM

The obvious thing is usually the last to be discovered.

Think of Safety

Great strides have been and are being made progressively in safety measures. The worker is becoming better and more completely protected personally. Big things have been done to guarantee owners against loss of investment and employees against being thrown out of work because of destruction of the plant.

One of the simplest and most obvious safety measures that should have been standard for glass plants long long ago has just recently began to become so. We refer to the building of a pit under each tank furnace to receive and hold the glass in case of a leak or break that gets beyond control.

Such a pit can be easily made and at little expense even under old tanks, in most instances. The space sacrificed cannot well be used anyway unless for block and brick storage and it's safer and better to store them elsewhere.

The sacrifice of the space and the cost of the pit are very cheap extra insurance. If fire insurance companies see the proposition as we do, they would be disposed to allow a worth while deduction from the rate on glass plants where the tanks have adequate safety pits under them.

Giving our product or job our best is like they say about love—"The more you give, the more you get."

Floors

A real problem for every industry is the decision on proper flooring materials for its factory. In some glass plants we have noticed successful floors in some departments and failures in others, or failures in all. But we have yet to meet the glass factory executive who is completely satisfied with every floor in his plant.

The most trouble is experienced with the floors in the factory proper or productive department and around, or more particularly, behind, the furnaces.

There are a great many things to be taken into consideration in the production department, things that vary considerably in different factories and which are concerning, chiefly, the different methods of operation; 1. What will be the maximum load the factory floor may be called upon to hold? 2. What will be hauled over it, such as molds, etc.? 3. Will it be required to stand up under piles of hot glass, etc.? 4. What will it do to the workmen's feet?

Our own experience and discussion with factory executives are both favorable to exceedingly hard paving blocks, or even extra hard red brick, laid on edge on a half inch layer of sand and well grouted with liquid cement.

The best floor we have ever seen behind a furnace had been made by laying big square sheets of ¼-inch "armor plate" on wet concrete. These were fitted up rather carefully for smooth joints but with joints open a little and screws with countersunk heads were put down through countersunk holes at corners and here and there as deemed necessary to hold the plates fast. The floor was exceedingly durable, smooth to shovel from and easier to keep free from gravel, grit, etc., which should not be shoveled in with the cullet. The danger of slipping on this floor was very great and for that reason, no plates were laid on a space right behind the dog houses where the tank filler stood when pushing in a charge of batch.

Praise

A nationally known after dinner speaker says he worked for a man for fifteen years and the only time he ever heard him say *"well done"* was when he ordered a steak.

We are all more or less susceptible to praise. When an extraordinary task is completed satisfactorily, one looks forward to some sort of commendation.

Cullet Storage

The cullet pile is usually a disreputable looking heap out in the factory back yard somewhere that seems to very well express the disgust and discouragement felt by the management at the time their product was being consigned to the cullet pile.

The cullet pile while not being worth what it costs, is worth something and will, we always hope, be used up sometime. When we do use it, there's no sense in having to spend a lot more on it. Also there's no point in letting it spread out and roll around over the yard so that it looks like there'd been an explosion in the middle of it. It gets dirty and is hard to recover.

A place that is handy so that it costs little to put cullet there and little to bring it back again, should be provided with a paved floor and with walls on three sides. The cullet will then be easy to shovel up and the pile cannot spread.

Of course, the ideal equipment is a crusher, conveyor system and bin but many consider these too much of an investment and anyway, when furnaces are repaired and at other times the regular bin's capacity is exceeded and there must be a pile.

It might be possible to arrange so that the outfit we have suggested could be so located that tank furnaces could be drained right into it just before the furnace is turned out for repairs.

We maintain that a respectable looking cullet pile costs less.

We like to work for the people, who, if we make good, will pay us well without our having to strike for it and if we don't make good will fire us. We want action. Action just suits men that are good, and, of course,—*we're good.*

Furnace Repair Schedule

When a furnace is turned out for repairs, big costs pile up. Several gangs, some of which are expensive laborers are put to work on the different jobs to be done and the time they put in at those jobs mean money in big sums. If the furnace is needed quickly for the sake of production, the time it is out means money in bigger sums.

A part of these sums can be saved by carefully planning the work beforehand as regards time and place,—particularly time. Place is incidental and included only so that the different gangs do not interfere with each other.

We suggest a schedule with the names of the gang foremen in the spaces across the top and the first, second, third, etc. weeks listed in order down the left side. The jobs to be done and time allotted to each should be listed under the proper foremen and opposite the week in which they are to be done. The schedule should be discussed in its making with these foremen and copies of it hung up around the furnace when the fire is turned out. Keep the men wisely distributed and, as far as possible, under the same foremen straight through and watch each gang try to get farther ahead of its schedule than the other. Even brick masons have been known to step lightly on the gas when all the other gangs were buzzing around them.

Somebody is being paid for knowing what we don't know,—yet.

All in a Glass Tank

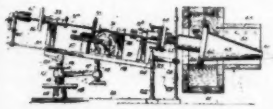
A "couple" of "batches" crawled out of the "dog houses," laid their "crowns" up on the "mantles" and "tuck (ed) stones" under the end of the "bridge" while standing in the "water (on a) log." Then they sat on the "skew blocks" and played "checkers" with a "draft" on the back of their "necks." Of course, they got sore "throats" and it's a wonder they didn't have the "flu (e)."

Recent Patents

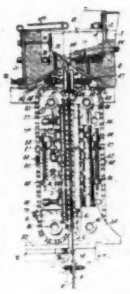
NEW INVENTIONS DESIGNED TO IMPROVE GLASS AND THE MEANS OF PRODUCING IT

Complete copies of U. S. Patent Specifications may be obtained from the Commissioner of Patents, Washington, D. C. Price 10c each

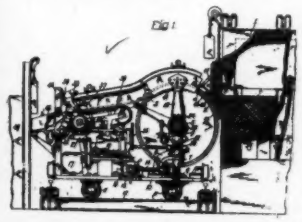
GLASS-WORKING APPARATUS. U. S. 1,550,995. Aug. 25, 1925. Albert C. Wilcox, Bridgeport, O. Filed 7/26/23. In apparatus for gathering and delivering glass to be drawn into tubes or rods a plate, a shaft rotatably mounted on said plate, a member on said shaft adapted to be partially immersed in a molten glass supply so as to elevate molten glass from the supply when said shaft is rotated, a forming surface adjacent to said member to which molten glass is delivered from said member, power means for rotating said shaft, and means for bodily elevating and lowering said plate to vary the depth of immersion of said member in the molten glass supply.



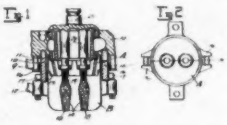
MANUFACTURE OF SHEET GLASS. U. S. 1,550,428. Aug. 18, 1925. Robert M. Corl, Maumee, O., assignor to Erie Glass Co. Filed 10/12/22. The method of producing glass in sheet form, consisting in allowing molten glass to take a sheet form by crowding it past a forming means to cause it to flow downward therefrom by gravity, gripping and supporting the sheet at intervals across its width as it flows from the forming means, the gripping means remaining in supporting contact with the sheet and moving therewith until the sheet has become substantially set, and severing the sheet at the points of support while in a soft condition.



MANUFACTURE OF GLASSWARE. U. S. 1,550,427. Aug. 18, 1925. Robert M. Corl, Maumee, O. Filed 5/29/20. A method of forming sheet glass, which consists in continuously flowing from a molten source of supply a sheet mass of glass, passing it through a temperature regulating chamber wherein it is permitted to cool sufficiently to maintain a shape and then bringing its forward end into physical contact with an electric heating means which melts the sheet mass to flow a sheet of less thickness therefrom, and carrying the finished sheet away from the sheet mass at the speed of flowing of the same from the mass.

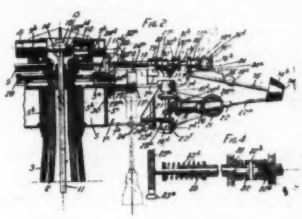


MOLD-CENTERING DEVICE. U. S. 1,549,920. Aug. 18, 1925. James H. Nigh, Fairmont, W. Va., assignor to Owens Bottle Co. Filed 10/20/21. An object of this invention is to maintain the blank mold and the finishing mold in exact alignment with the neck mold during the glass gathering and blowing operations respectively. The claims include the combination of molds each comprising separable sections, and a centering pin between the mold sections, said molds arranged at different positions lengthwise of said pin and controlled in their axial rotation by the pin when their sections are brought together.

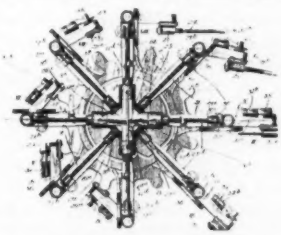


PROCESS OF TREATING GLASS DURING ANNEALING. U. S. 1,553,283. Sept. 8, 1925. John Bennett, Steubenville, O. Filed 5/22/24. The object is to increase the thermal endurance and mechanical strength of glass articles by rarefying the air in contact with such articles while they are cooling. The glass articles are placed within the receptacle while hot, the latter closed air tight and a portion of the air exhausted thus lessening the atmospheric pressure upon the articles thereby permitting the expansion of the glass and retarding the cooling of the same, permitting the equal distribution of the heat during the cooling process and facilitating the liberation of the gases from the glass.

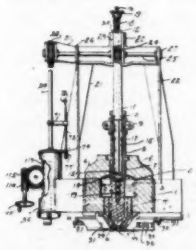
GLASS-WORKING MACHINE. U. S. 1,551,934. Sept. 1, 1924. Benjamin D. Chamberlin, Corning, N. Y., assignor by Mesne Assignments, to Hartford-Empire Co. Filed 3/23/10. A marvering mechanism associated with a rotating frame by which the several parts are carried, and by the rotation of which the glass-working spindles, which are specifically in the form of gathering blow pipes, are projected into a furnace to effect a gather of glass, are withdrawn therefrom, are positioned in proper co-operative relation with the marverer, are then oscillated for the purpose of securing elongation of the glass, and are then positioned above a mold in which such elongated and marvered gatherer is blown.



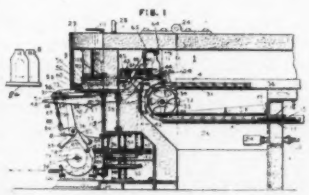
MACHINE FOR THE PRODUCTION OF GLASS ARTICLES. U. S. 1,551,933. Sept. 1, 1925. Benjamin D. Chamberlin, Washington, D. C., assignor by Mesne Assignments, to Hartford-Empire Co. Filed 3/23/10. A machine adapted not only to perform glass blowing operations but adapted also to perform certain operations which are preliminary to blowing (including the gathering of the glass upon the pontee or blow-pipe, the marvering, or the elongation of the gather by swinging, or any or all of these steps) and if desired it is also adapted to remove the finished article and to clean the moil from the pontee or blow-pipe preliminary to a new gather.



GLASS-FEEDING APPARATUS. U. S. 1,551,526. Aug. 25, 1925. Frank O'Neill, Toledo, O. Filed 1/2/23. A feeder for glass from a tank having a bottom opening, embodying a hinge pin, one on each side of said opening, a vessel section mounted on each hinge pin and swingable to closed position below the tank opening and dropping away from the opening in swinging apart, a shear for severing a gather of glass between the opening and the vessel sections, and power drive for opening the sections in permitting dropping of the gather from the vessel sections as severed by the shear.

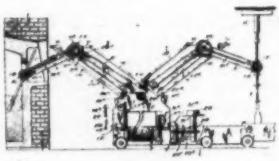


INITIAL-HEAT LEHR AND AUTOMATIC FEEDING EQUIPMENT. U. S. 1,552,941. Sept. 8, 1925. Wilbur S. Mayers, Fairmont, W. Va. Filed 9/25/20. Differs from the old method in that the ware is taken hot from the mold set as close as practicable to the lehr and transferred to a heat insulated chamber in a space of time short enough to prevent the cooling of the ware below a certain critical temperature at which annealing is impossible without reheating. Among the inventor's claims is a lehr comprising interconnected receiving- and cooling-chambers, a combustion-chamber, a main-conveyor partly within the chambers, a

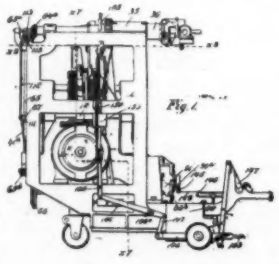


horizontal rotative disk, a cross-conveyor within the receiving-chamber, in working relation to the disk, automatic means for moving the ware from the cross-conveyor to the main conveyor, means for heating the conveyors and other carrier parts within the combustion- and receiving-chambers and for maintaining a constant temperature in receiving chamber. (See detailed description THIS JOURNAL, September, 1923.)

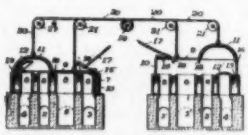
APPARATUS FOR GATHERING GLASS AND THE TREATMENT THEREOF ON BLOWPIPES. U. S. 1,551,935. Sept. 1, 1925. Benjamin D. Chamberlin, Washington, D. C., assignor by Mesne Assignments to Hartford-Empire Co. Filed 4/23/09. This invention includes means for automatically gathering, marvering and swinging and blowing glass articles on the end of a blow-pipe without the intervention of manual actions between the successive operations. It includes the combination with a blow-pipe receiving device, of a marverer consisting of a plurality of cam shaped positively driven rollers, means for translating the blow-pipe receiving device and for holding it stationary at marvering and blowing positions, means for swinging the blow-pipe on a horizontal axis to present it vertically at the marvering and blowing positions and to incline it at the gathering position.



MACHINE FOR PRODUCING BLOWN-GLASS ARTICLES. U. S. 1,551,936. Sept. 1, 1925. Orin A. Hanford, Rochester, N. Y., assignor, by Mesne Assignments to Hartford-Empire Co. Filed 10/27/09. A movable blow-pipe frame adapted to receive and support a blow-pipe with a gather of glass thereon, and to be oscillated to swing the blow-pipe for properly distributing the gather and presenting it to the mold, the mold mechanism being located in front of the bottom of the main frame, and below the shaft of the blow-pipe frame; a marverer or block adapted to act upon the gather, molds adapted to close upon the gather and open and be cooled after the blowing, and mechanism for controlling the air pressure in the gather.

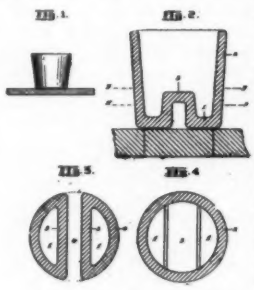


REVERSING APPARATUS FOR REGENERATIVE FURNACES. U. S. 1,553,242. Sept. 8, 1925. George H. Isley, Worcester, Mass., assignor to Morgan Construction Co. Filed 4/8/20. The gas from the supply flue enters beneath the hood portion of left hand reversing device and then passes into the gas regenerator flue, traveling through the furnace toward the right. Air enters the flue through an opening in the left hand device, this opening being controlled by a swinging damper which is held open by a chain, or the like, adjustably secured to some fixed point. Obviously, when the device is raised, the cover or damper will close by gravity. The left hand stack flue terminal is completely isolated from the entering gas and air by the depending surrounding flange which forms a seal with the water in pan. The products of combustion leave the furnace by the right hand side, that is, through the flue terminals 3' and 2' that are uncovered, owing to the raising of the right hand reversing device. The supply of gas is completely shut off due to the closure by gravity of the swinging cover associated with the extension of this flue terminal. Consequently, all the burned gases, leaving by way of regenerator flues and pass into the space under the device and make exit therefrom through the stack connection flue. When it is desired to reverse the course of burning gases through the furnace, the left hand device is raised, and the right hand device is simultaneously lowered.

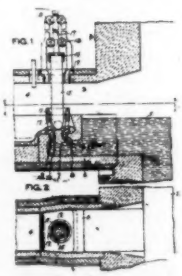


METHOD OF AND APPARATUS FOR FORMING GLASS SHEETS. 1,549,541. Aug. 11, 1925. William E. Heal, Washington, D. C. The method of forming sheets of glass which comprises placing a layer of semi-fluid glass upon the periphery of a gathering roll, separating the glass from the roll at spaced points by means of a fluid current introduced beneath the layer of glass, revolving the roll to feed the glass outwardly at said points of separation and form a plurality of pairs of spaced sheets, and introducing air between the sheets of each pair during their formation to prevent collapsing.

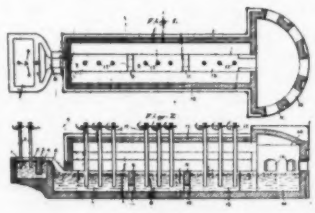
POT FOR MELTING GLASS. U. S. 1,552,884. Sept. 8, 1925. Hans Schnurpfeil, Carlsbad, Czechoslovakia. Filed 4/8/25. The object is to obviate the disadvantage that with ordinary flat bottom pots (Fig. 1) a substantially smaller heating effect is produced on the raw material located at the bottom of the crucible than on the material located in the upper part of the pot directly exposed to the temperature prevailing in the upper space of the furnace. The time occupied in melting is therefore excessively long and the consumption of fuel very great, in addition to which the life of such crucibles is comparatively short. This invention consists essentially in providing the bottom of the crucible with one or more hollow ribs projecting into the interior thereof and opening on the outside of the pot, so that the flames and combustion gases have unimpeded access to the interior of the ribs.



VALVE FOR MOLTEN GLASS. U. S. 1,553,290. Sept. 8, 1925. George E. Howard, of Butler, Pa., assignor to Hartford-Empire Company. Filed 4/13/23. One object is to provide a valve for controlling the flow of molten glass from a tank furnace to a boot or a glass feeder, the valve being so constructed and arranged as to receive the glass from beneath the glass level in the tank furnace, thereby furnishing to the feeder a constant supply of fresh hot glass. Among the inventor's claims is glass-handling apparatus comprising a container for molten glass provided with a cover having an opening, a supporting member removably disposed in said opening, a movable valve member supported by the supporting member, and a normally stationary valve member co-operating with said movable valve member, the valve member being removable from apparatus through the opening when supporting member is removed.

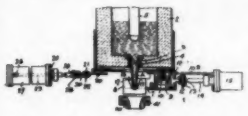


GLASS-REFINING FURNACE. U. S. 1,552,555. Sept. 8, 1925. Allan Grauel, Oshawa, Ont., Can., assignor of one-tenth to Frederick C. Hoar, Bowmanville, Ont., Can. Filed 1/20/23. The inventor claims in a glass refining furnace, having a unitary melting pot in which the glass is melted by electrodes and divided by a partition to form heating and float chambers, an outer structure having a plurality of transverse partitions dividing the interior into a plurality of narrow chambers, each of said partitions having openings through the bottom, said float chamber being arranged to overflow into one of the chambers and heating electrodes extending through the top of the furnace into each of said chambers and adapted to maintain independent temperatures in the different chambers.

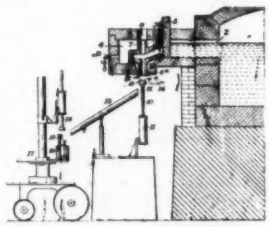


GLASS-FORMING MACHINE. U. S. 1,550,152. Aug. 18, 1925. Albert N. Cramer, Toledo, O., assignor to the Owens Bottle Co. Filed 3/16/22. An object of the invention is to provide a practical form of mold bottom and actuating mechanism therefor which will permit the use of finishing molds of different lengths to be used simultaneously, so that bottles or other articles of different lengths may be manufactured at the same time on the machine. Also to provide a mold bottom and operating means therefor by which the glass blank is under complete control during the transfer of the blank from the blank mold to the finishing mold.

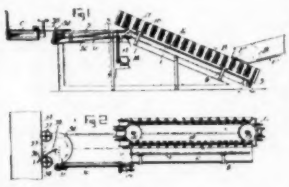
METHOD AND APPARATUS FOR FEEDING GLASS. U. S. 1,552,497. Sept. 8, 1925. Olbert C. Noble, Grafton, W. Va., assignor to Tygart Valley Glass Co. Filed 10/13/21. The novel features consist in a particular arrangement of the cup and the shears with respect to the outlet orifice; and in a particular relation between the shape of the accumulating cup and the shape of the mold, whereby the accumulating cup gives the gather a shape differing from the shape of the mold sufficiently to cause the glass, when delivered into the mold, to enfold the sheared stub of glass and thoroughly reheat the portions chilled by the shears. The first feature eliminates laps and blisters, and the second eliminates shear marks from the product.



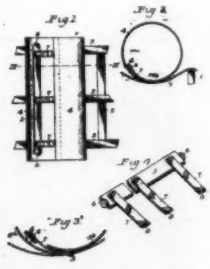
METHOD AND APPARATUS FOR FEEDING GLASS. U. S. 1,551,513. Aug. 25, 1923. Benjamin T. Headley, David I. Du Bois and William C. Fenimore, Millville, N. J. Assignors to Whitall-Tatum Co. Filed 3/15/21. The inventors claims in the method of forming glass gathers, the steps consisting in producing a stream of glass, temporarily mechanically contracting and supporting the free end only of said stream to decrease the normal flow tendency of the glass under the influence of gravity while maintaining the entire body of the stream in motion, severing the stream to form a gather, and delivering the gather to a mold, substantially as described.



MECHANISM FOR HANDLING BOTTLES, ETC. U. S. Re. 16,151. Sept. 1, 1925. Merton C. Heath, Muncie, Ind. Reissue filed 9/24/23. The combination with a movable apron and a conveyor adjacent thereto, of a rotary disk in close relation to the apron and in position to receive bottles from the apron, means overlying and terminating at the center of the disk and projecting over the conveyor in a position to intercept a bottle on the disk and to direct it onto the conveyor, a guard wheel overlying the disk and the conveyor and mounted to rotate on an axis parrallel with the axis of the disk, and means for rotating the disk and for moving the apron in the direction to discharge thereto.



METHOD AND APPARATUS FOR SPLITTING GLASS CYLINDERS. U. S. 1,553,103. Sept 8, 1925. Paul R. Pike, of Jeannette, Pennsylvania, assignor to Window Glass Machine Company, of Pittsburgh, Pa. Filed 1/18/24. A method and apparatus directed toward the prevention of scratches when glass cylinders are divided into two or more sections or shawls. With the usual method of splitting, the glass cylinder is "burned" at one point around its circumference, and then rotated on the splitting buck so that this portion is uppermost. The lower edge is then split with the hot iron and a cutting wheel is applied to the burned or scored portion, so that a second split occurs at this point. When this is done, the two shawls tend to fall away from one another at the top, and they then slide toward each other on the splitting buck, and one of them generally slides inside the other. When this happens, the jagged edge frequently scratches the other shawl, thus materially reducing the quality of the glass produced. This invention provides for inserting a separator between the edges formed by one splitting operation to prevent scratching of the glass by such edges when a subsequent split is made.



GLASS-FORMING MACHINE. U. S. 1,550,346. Aug. 18, 1925. Albert N. Cramer, Toledo, O., assignor to the Owens Bottle Co. Filed 4/30/23. An object of the invention is to provide a combined mold and guide which will permit the charges of glass to be directed into the mold as the latter passes the charging station, without the necessity of a funnel guide and to provide a mold closing head, or a combined mold closing and blowing head adapted to cooperate with said combined mold and guide.

PROCESS OF PRODUCING DECORATIVE EFFECTS ON GLASS. 1,537,663. May 12, 1925. William Fox, Detroit, Mich. Filed 6/13/24. The invention includes a process of producing decorative effects on glass comprising applying drops of paint of various colors on the reverse side of dry clean glass and applying air thereto from varying angles.

PROCESS OF MOLDING BOTTLES. U. S. 1,554,464. Sept. 22, 1925. John Rau, Indianapolis, Ind., assignor to Fairmount Glass Works. Filed 4/24/25.

APPARATUS FOR SURFACING SHEETS. U. S. 1,554,804. Sept. 22, 1925. John H. Fox, Pittsburgh, Pa., assignor to Pittsburgh Plate Glass Co. Filed 9/13/23.

APPARATUS FOR APPLYING POLISHING MATERIAL. U. S. 1,554,809. Sept. 22, 1925. Frederick Gelstharp, Tarentum, Pa., assignor to Pittsburgh Plate Glass Co. Filed 6/6/21.

PROCESS AND APPARATUS FOR DRAWING GLASS. U. S. 1,554,848. Sept. 22, 1925. Herman S. Heichert, Pittsburgh, Pa., assignor to Pittsburgh Plate Glass Co. Filed 8/9/21.

APPARATUS FOR DRAWING SHEET GLASS. U. S. 1,554,850 Sept. 22, 1925. Halbert K. Hitchcock, Pittsburgh, Pa., assignor of one-half to Hitchcock Experiment Co. Filed 10/11/22.

PROCESS AND APPARATUS FOR MAKING SHEET GLASS. U. S. 1,554,851. Sept. 22, 1925. Halbert K. Hitchcock, Pittsburgh, Pa., assignor of one-half to Hitchcock Experiment Co. Filed 12/9/24.

APPARATUS FOR MAKING SHEET GLASS. 1,554,852. Sept. 22, 1925. Halbert K. Hitchcock, Pittsburgh, Pa., assignor of one-half to Hitchcock Experiment Co. Filed 12/26/24.

METHOD FOR THE PRODUCTION OF DOUBLE-WALLED GLASS VESSELS. U. S. 1,554,853. Sept. 22, 1925. Wilhelm Hodecker, Ilmenau, Thuringen, Germany. Filed 3/7/24.

PROCESS OF DRAWING SHEET GLASS. U. S. 1,554,886. Sept. 22, 1925. Harry G. Slingluff, Mount Vernon, O., assignor to Pittsburgh Plate Glass Co. Filed 3/26/23.

APPARATUS FOR FABRICATING REINFORCED GLASS. U. S. 1,553,667. Sept. 15, 1925. William C. Bull, Brooklyn, N. Y. Filed 6/26/24.

METHOD OF MAKING GLASS PLATES. U. S. 1,553,773. Sept. 15, 1925. William E. Heal, Washington, D. C. Filed 9/6/24.

FEEDING MOLTEN GLASS. U. S. 1,553,819. Sept. 15, 1925. George E. Howard, Butler, Pa., assignor to Hartford-Empire Company. Filed 4/4/23.

MACHINE FOR FIRE POLISHING AND FINISHING GLASSWARE. U. S. 1,554,038. Sept. 15, 1925. Andrew J. Sanford and John B. Townsend, Newark, O., assignor to A. H. Heisey & Co. Filed 8/30/23.

GLASS MOLD-FILLING APPARATUS. U. S. 1,554,195. Sept. 22, 1925. William G. Bergman, Toledo, O. Filed 12/24/19.

GLASS-MELTING FURNACE. U. S. 1,554,251. Bjarne H. Schieldrop, Charleston, W. Va., assignor to the Libbey-Owens Sheet Glass Co. Filed 2/24/23.

DRAWING SHEET GLASS. U. S. 1,554,267. Sept. 22, 1925. Robert G. Ewing, Toledo, O. (Beatrice A. A. Ewing, executrix), assignor to Libbey-Owens Sheet Glass Co. Filed 4/5/20.

COOLER-CHAMBER CONSTRUCTION. U. S. 1,554,268. Sept. 22, 1925. Enoch T. Ferngren, Toledo, O., assignor to the Libbey-Owens Sheet Glass Co. Filed 12/23/24.

SHEET-GLASS APPARATUS. U. S. 1,554,269. Sept. 22, 1925. Enoch T. Ferngren, Toledo, O., assignor to the Libbey-Owens Sheet Glass Co. Filed 12/26/24.

LEHR. U. S. 1,554,275. Sept. 22, 1925. Robert Good, Washington, Pa., assignor of one-half to Hazel-Atlas Glass Company. Filed 1/27/23.

GLASS AND COMPOSITION THEREFOR. U. S. 1,545,508. July 14, 1925. Robert J. Montgomery, Rochester, N. Y., assignor to Bausch & Lomb Optical Co. Filed 4/2/23. A crown glass comprising antimony oxide in excess of one percentum and less than twenty percentum.

Glass Factory Equipment and Supplies

Most of the information printed in this department comes direct from the manufacturers of the products described.

Link-Belt Equipment for Glass Plants

Many varied applications to glass factories of the Link-Belt Company's engineering service and their equipment for unloading, storing, distributing and feeding batch materials and handling finished products are illustrated and briefly described in a new 12-page pamphlet "Link-Belt Equipment for Glass Plants" recently

FIG. 1. POWER SHOVEL FOR UNLOADING RAW MATERIALS FROM BOX CARS.

issued and obtainable on request from the company's office at 300 W. Pershing Road, Chicago, Ill.

A description of the Link-Belt materials handling system begins with the power shovel (Fig. 1), which enables the operator to quickly unload the contents of a box car into the receiving hopper of a traveling elevator, which moves under its own power from one to another of the storage bins; or into a stationary elevator

FIG. 2. BATCH CAR ELECTRICALLY PROPELLED.

permanently attached to one of the bins, in which case the materials are distributed to the proper bins by means of a horizontal belt conveyor traveling across the top of the row of bins. From the bins pre-determined charges of the various materials are automatically weighed and deposited in a self-propelled batch mixing car (Fig. 2), which makes a homogeneous mixture of the batch ingredients and transports it to the melting furnace or batch bin.

Where salt cake is stored, much time can be saved by installing between the storage bin and the weigh hopper a salt cake crusher and an auxiliary hopper to hold the crushed cake. The crushing operation can then proceed continuously, the auxiliary hopper serving as a temporary storage for the crushed salt cake between the mixing of successive batches. From the auxiliary hopper the crushed cake is discharged into the weigh hopper, and from the weigh hopper into the batch mixer car. While the car is delivering the batch to the furnace the auxiliary hopper is refilled with crushed salt cake and is again ready to be emptied on the car's return.

The batch elevating and distributing system can also be used for handling cullet, whether mixed with the batch or stored separately at the furnace. When the cullet is separated from the batch, the overhead bins at the furnace have two compartments, each with

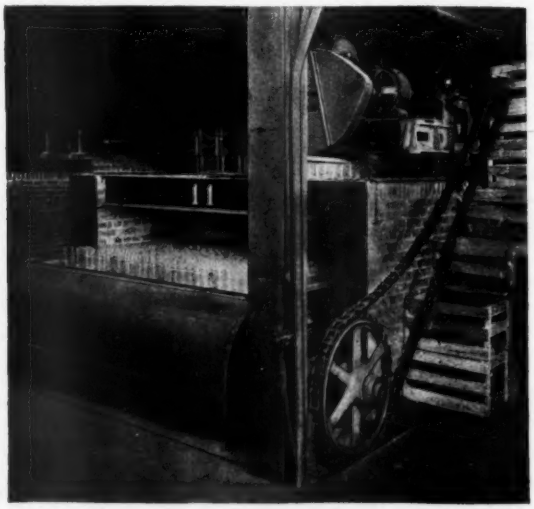


FIG. 3. LEHR CONVEYOR AND DRIVING MACHINERY.

its own outlet gate, but a common collecting hopper and spout for delivery to the dog house. If the batch and cullet must be charged in definite amounts, all that is needed to insure proper proportioning of the two is a weigh hopper installed under the overhead bin.

Where various colors or grades of cullet must be kept separate, the Link-Belt partitioned pan conveyor can be used to advantage. This keeps the different kinds of cullet separate and delivers them to separate crushers or to a crusher with partitioned rolls.

In addition to raw materials and coal unloading and storage plants, special types of Link-Belt conveyors are built for installation in lehrs (Fig. 3) and for carrying glassware to and from the lehr, making annealing a continuous operation.

The motor and gears for driving the lehr conveyor are mounted in an iron frame on top of the brickwork over the lehr, where they are out of the way, and are easily accessible for inspection and maintenance.

It becomes necessary at times in glass plants to empty melting tanks and dispose of the molten glass; the old slow, laborious method of hand ladling is too costly. A means of overcoming the difficulty is now provided, whereby a high speed motor driven Link-Belt shrending conveyor receives the molten glass from the tank draw-off, cools and shrends it into flakes with water jets, and conveys it outside the building (Fig. 4) where a Link-Belt portable conveyor carries the cullet to the storage pile.

In window glass plants using the cylinder process the glass that remains in the pot after the drawing operation is completed is taken

by Link-Belt conveyors, shrended under a stream of water and delivered in the form of hot cullet to the dog house for remelting.

Numerous other examples of applications of Link-Belt equipment are given in the pamphlet referred to above, including conveyors for passing finished glassware before inspectors at any desired speed to packing tables, for delivering empty barrels and boxes from

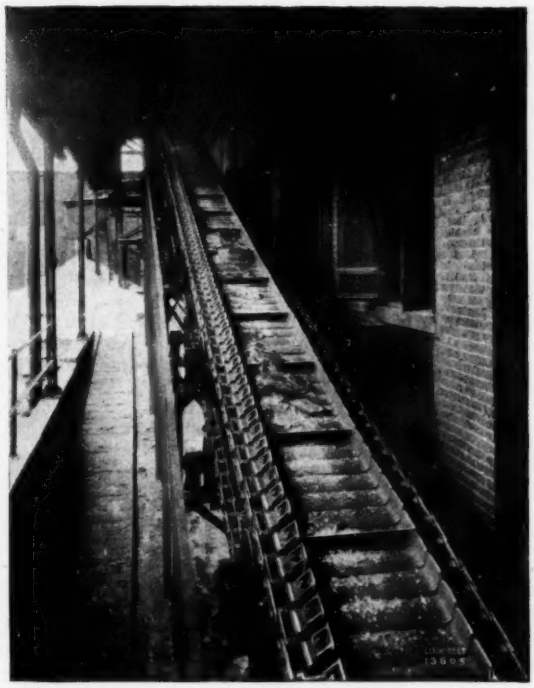


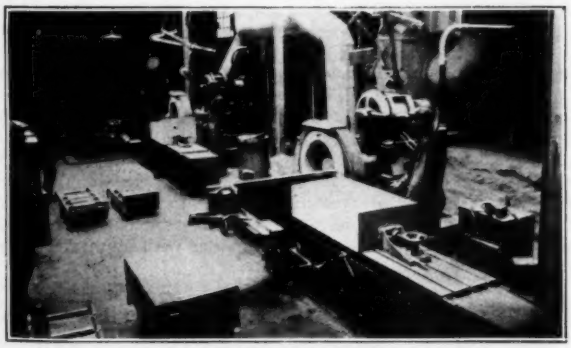
FIG. 4. LINK-BELT CONVEYOR FOR MOLTEN GLASS.

cooperage or box factory to packing room, and filled ones to warehouse, shipping platform or car.

Link-Belt locomotive and crawler type cranes are useful in the yard for handling coal, sand, cullet, and other materials between cars, storage piles and bins. Link-Belt silent chain is used extensively for driving air compressors, lehr conveyors and other machinery.

Bridgeport Tank Block Grinding Machine

Tank blocks that are exact in all dimensions with each face a perfect plane have obvious advantages over any other kind. Prior to the recent adoption of the practice of grinding blocks to true form after they have passed through the final burning process, tank blocks were sometimes ground while in the green condition. While this gave the general shape to the block, it did not overcome warping and twisting in the kilns,

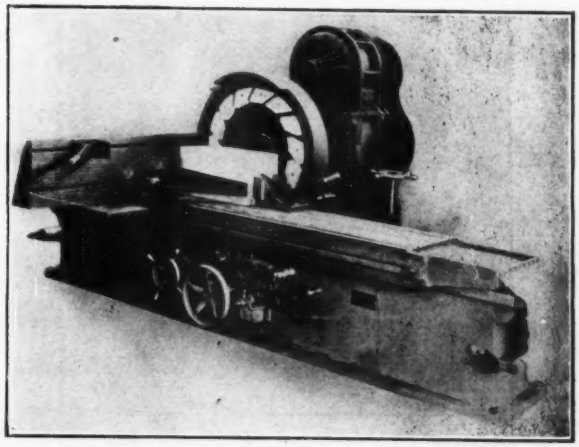


OHIO VALLEY CLAY COMPANY'S INSTALLATION AT THEIR STEUBENVILLE, OHIO, PLANT.

and it was necessary after the blocks were burnt to dress them by chipping and rubbing, in order to get a tight fit. Then, too, when the blocks were ground green, the corners would frequently fall out and the blocks would have to be patched up, which did not make a satisfactory job.

Blocks that are ground after being burnt, measure true to the dimensions and insure a large saving when it comes to building the blocks into the walls of the tank.

A facing machine built by the Bridgeport Safety Emery Wheel Company, Bridgeport, Conn., has been successfully applied to the grinding of tank blocks, an installation of two machines for that purpose at the plant of the Ohio Valley Clay Company, Steubenville, O., being illustrated here. The machine is a regular type of face grinder with special fixtures added to the table. On the left-hand side a heavy bracket is bolted to the table at right angles, against which the clay

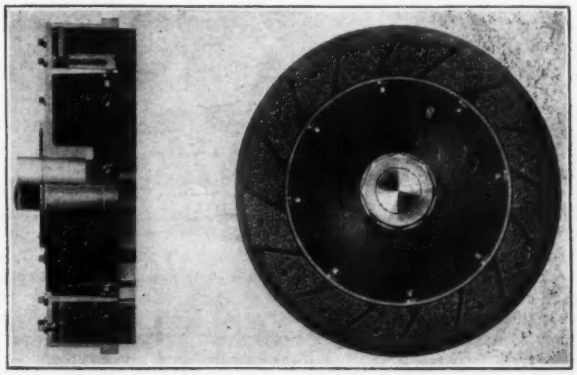


MACHINE IS A REGULAR TYPE OF FACE GRINDER WITH SPECIAL TABLE FIXTURES.

block can readily be placed. After one side is faced and placed against the cast iron bracket, the other faces can be ground true and at right angles. A support is also placed on this bracket so that the outer end of the long blocks can be held rigidly in position when being faced on the ends.

The grinding is accomplished by the use of a steel casting chuck in which are mounted sectional abrasive blocks. This is clearly illustrated in the photograph of the chuck. This produces a shearing action in the cutting of the tank blocks and provides clearance for the material as ground off.

Prior to the use of the Bridgeport sectional wheel, attempts were made, the manufacturers state, to use solid ring



SECTIONAL ABRASIVE GRINDING WHEEL.

wheels; these, however, provided no clearance for the material as ground off and caused bedding back into the face of the wheel, which prevented cutting.

The abrasive sections are 4 inches wide, 8 inches deep, forming a wheel 32 inches in diameter. As the sections are reduced by grinding, they can be moved forward and additional grinding surface exposed. Under ordinary conditions they are moved out 2 inches and require no further attention until this amount of abrasive is taken off.

The Austin Company and Its New Book of Buildings

The name of The Austin Company has become well known in the glass industry because of the extensive activities of the organization and the unusual records made by it during the past few years in the construction of numerous glass manufacturing plants, electric lamp factories and other structures. It is safe to say, however, that very few of the thousands of executives and operating officials in the industry have had a really adequate conception of the extent and importance of the engineering and building projects successfully undertaken by this concern. For the purpose of more fully acquainting those in the glass and other industries who are, or later may become interested in modern trends in the de-

sign, construction and equipment of industrial and commercial buildings, the company has just brought out the eighth edition of "The Austin Book of Buildings," a handsome, well-made volume, measuring 8½ by 11 inches and containing 96 pages, with more than 150 photographic illustrations and many diagrams.

Section I of the book is an exposition of the Austin Method of Building Service in the United States and foreign countries. This service comprises, first, the making of surveys to determine the advantages or disadvantages of any locality or site. Then a thorough plant study is made to assure proper procedure for expansion, both present and future. Assistance in financing building projects is extended when desired, upon mutually satisfactory terms.

The layout of the building, or the entire plant, as the case may be, is very carefully studied so as to assure the best possible results according to the client's particular requirements, and the accomplishment of this object is greatly facilitated through the 50-year long and intimate experience of the Austin Company with manufacturing problems of many kinds.

The design of the buildings incorporates the best standard practice, with careful thought to the special uses, present and future, to which they are to be put and with a view to obtaining the proper proportions between the various parts to produce a pleasing architectural appearance, as well as utility, without entailing excessive cost.

In the purchase of certain building materials, the Austin Company is the largest buyer in the world and its market connections and traffic department's systematic service are important factors in effecting savings, assuring good quality of materials and expediting delivery of them to the job, thus making practically certain the finishing of work on scheduled completion date.

An additional feature of the company's service is its willingness to contract, not only for the building but also for the installation of equipment for either a single department or a complete unit such as a power plant or a material handling system, and to prepare specifications, purchase and install heating, lighting, plumbing, ventilating and other similar equipment.

The book also describes the company's organization and facilities. A national system of permanent offices, each manned by a trained, experienced staff is maintained in the principal cities of the United States, where complete Austin service covering engineering, design, construction, equipment, etc., is available. The company operates a large steel fabricating mill at Cleveland, where large stocks are carried, has its own equipment for heavy construction work and all kinds of light equipment. Storage yards are maintained at various strategic locations.

Section II of the book contains illustrations, diagrams and data on all Austin standardized types including both single and multi-story buildings of steel and wood frame, mill types and reinforced concrete structures. Austin's material sales service and building equipment service are also described.

Section III contains illustrations, description, recommendations and comparative costs of various constructions for floors, doors, walls, wall facings, roof structures and roof waterproofings.

The book is profusely illustrated with exterior and interior views of plants all over the country constructed by the Austin Company. The glass industry is one of those which has been developed most extensively from the Atlantic to the Pacific coasts and from the Province of Alberta to Chesapeake Bay. Many prominent plate and window glass, tableware, molded glass and pharmaceutical glass plants are included among its list of domestic and foreign clients.

The Austin Book of Buildings contains a large amount of information that should prove interesting to anyone contemplating factory enlargements or new plant construction.

Electrical Equipment at Creighton

An interesting modification of substation construction, adapted to local circumstances for the purpose of securing necessary floor space on a restricted ground area, is made at the Pittsburgh Plate Glass Company plant at Creighton, Pa. This plant was newly built about two years ago and, for the past several months, plans have been under way for doubling its capacity.

In common with most industrial plants in the vicinity of Pittsburgh, the Pittsburgh Plate Glass plant is confined to a rather narrow section of land between mountains and river, the only level ground being along the banks of either the Monongahela or Allegheny rivers. The natural topography of the land thus allowed a maximum width for the substation in question of but 20 feet, with no restriction, however, on the height of the building.

Acting, therefore, on principles of land conservation practices in large and crowded cities, the Pittsburgh Plate Glass Company designed the substation for its Creighton plant for a height of four stories. This type of construction was adopted when the plant was first built, two years ago, the company officials foreseeing, at that time, the present expansion. Outdoor switching equipment was also designed, at the beginning, for the ultimate capacity of the plant.

All the electrical equipment in the substation and a considerable part in the plant is of General Electric manufacture, the plant being completely electrified. Power is purchased from the West Penn Power Company, Pittsburgh, Pa., is received from two 25,000 volt, three-phase, 60-cycle, transmission lines, and is stepped down by transformers to 550 volts.

Inside the substation were originally installed two 300-kilowatt motor generators for supplying direct current to cranes and auxiliary motors, one low tension switchboard for operating the motor generators and for controlling feeder circuits, and a 3,000-kv-a. synchronous condenser for improving the power factor on the induction motor load. In doubling the plant capacity, the present motor generators will be replaced by 600-kilowatt sets, and a second synchronous condenser of the same rating will be installed together with duplicate transformer equipment.

Vitrox—A New Ceramic Material

The Vitrefrax Company, Los Angeles, Cal., has brought out, after two years of intensive research and commercial tests, a new product—Vitrox—the function of which is to increase the strength of clay products, reduce warpage and control shrinkage. This is a product resulting from the processing of a new aluminum silicate ore of peculiar physical structure.

The Glass World and What It Is Doing

News of the Industry

August Construction Highest on Record

August had the highest total of construction contracts on record, according to a statement issued September 13 by F. W. Dodge Corporation. New construction work started in the 36 eastern states (which include about ⅞ of the total construction volume of the country) amounted to $589,690,200. The previous high record was in March of this year, with a total of $546,970,700. The August increase over July was 11 per cent; over August 1924, 66 per cent.

Construction started in the 36 eastern states during the past eight months has reached a total of $3,778,792,000, an increase of 25 per cent over the corresponding period of 1924, and by far the largest amount for any similar period of any year. At the end of June, this year was 15% ahead of 1924; at the end of July, 20% ahead; and at the end of August, 25% ahead. This shows the rapidity of the rise in building activity during the past few months.

The big August Volume was to an extent due to largely increased activity in and around New York City, where up to July 1, this year's building activity was comparatively low. August was a record month in building contracts in New York and vincity, as well as in the entire territory covered in the F. W. Dodge Corporation's records.

Last month's building contract record included: $263,485,000, or 45% of all construction, for residential buildings; $105,848,900, or 18%, for commercial buildings; $33,667,200, or 6%, for educational buildings; $32,472,200, or 6%, for social and recreational projects; and $22,692,800, or 4%, for industrial buildings.

Contemplated new work reported for the 36 states in August amounted to $820,602,200, which also broke all previous records. There was an increase of 17% over the contemplated work reported in July, and of 62% over the amount reported in August of last year.

American Ceramic Society Fall Meeting

The fall meeting of the American Ceramic Society is being held in connection with the Tenth Exposition of Chemical Industries at the Grand Central Palace, New York. October 1 is Ceramic Day. Among the speakers are: Alexander Silverman, Charles W. Hill, M. C. Booze, R. D. Landrum, A. P. Potts, F. H. Riddle, W. K. McAfee, Jane Hoagland, Edmund de F. Curtis, and Richard F. Bach of the Metropolitan Museum of Art. Dr. E. Ward Tillotson of Mellon Institute, president of the American Ceramic Society, presides. A reel "Story of a Glass Bottle" by the Illinois Glass Company is being shown. Also one on "Lime: Its Manufacture and Use in Industry and Construction," by the National Lime Association and B. & O. R. R. A banquet is scheduled for Thursday evening, October 1, at the Hotel Roosevelt, the American Ceramic Society co-operating.

A one week's students' course in chemical engineering practice is being given while the exposition is going on. It includes lectures on "Handling of Materials," by A. E. Marshall, Corning Glass Works, Corning, N. Y.; and "Materials of Construction—Ceramic Materials to use in Chemical Plant Construction," by Ross C. Purdy, secretary of the American Ceramic Society. On Friday, October 2, A. E. Marshall of Corning Glass Works, will give a lecture on "Pyrex Glass."

Some of the exhibitors are: American Lime & Stone Company, Associated Cooperage Industries of America, Bausch & Lomb Optical Company, Beach-Russ Company, Bristol Company, Brown Instrument Company, Carborundum Company, Celite Products Company, Corning Glass Works, Dings Magnetic Separator Company, Eagle-Picher Lead Company, Eimer & Amend, Chas. Engelhard, Inc., Federal Abrasives Company, General Electric Company, Emil Greiner Company, Hanovia Chemical & Manufacturing Company, L. O. Koven & Bro., Inc., Leeds & Northrup Company, Mathieson Alkali Works, Inc., Metal & Thermit Corporation, National Lime Association, New Jersey Zinc Company, Norton Company, Quigley Furnace Specialties Company, Salem Glass Works, B. F. Sturtevant Company, C. J. Tagliabue Mfg. Company, Taylor Instrument Companies, Uehling Instrument Company and Westinghouse Electric & Manufacturing Company.

R. J. Montgomery Now Ceramic Lecturer at Toronto

Announcement has been made of the appointment of Robert J. Montgomery, well known ceramist, as lecturer in ceramics in the Department of Metallurgical Engineering at the University of Toronto, Canada, where a new department of ceramic engineering is being established. This work was started at the request of the Canadian National Clay Products Association and considerable aid is being given by this organization in financing the course.

Mr. Montgomery, since his graduation from the Ceramic Department of the Ohio State University in 1911, has been connected with ceramic industries in various capacities. During the four and a half years from 1911 to 1915 he was with the Pittsburgh Plate Glass Company's clay research laboratory at Creighton, Pa. The work there was divided between clay research, making a survey of the refractory clays of the United States, and works control in the various factories of the company. This included standardization of methods of making and drying glass pots and furnace refractories of all kinds. Success was met with in substituting American clays for German bond clay and developing the bodies for the glasshouse refractories which are now being used and sold by that company.

Two years, from 1916 to 1917, were spent by Mr. Montgomery in charge of the refractories and high temperature division of the H. Koppers Co.'s laboratory at the Mellon Institute, Pittsburgh, where he was responsible for the quality of the refractories used in the coke ovens built by the company. Standard methods of testing fire clays, silica brick and mortar clays were developed. Various grades of material were established.

After the war, Mr. Montgomery became connected with the Bausch & Lomb Optical Company, Rochester, N. Y., to devote his efforts to the making of optical glass pots. He soon took over the work of melting optical glass in addition to the manufacture of the pots and furnace refractories and took charge of the technical development work as well. This included the development of the porcelain type of pot for the more corrosive glasses and the development of new optical and spectacle glasses now being made in the United States.

Toronto University is to be congratulated on obtaining the services of a trained ceramist of such wide practical experience at the beginning of its ceramic engineering activities.

Pittsburgh's Production of Glass

Pittsburgh's proud position as a glass as well as a steel manufacturing center is prominently set forth in a recent article in *Pittsburgh First*, the official organ of the Chamber of Commerce of that city. The writer gives the early history of glassmaking in the Pittsburgh district, the first factory being established there in 1797 by Major Isaac Craig and James O'Hara. This was the first glass plant west of the Alleghenies and the first in the United States to use coal for fuel. Window glass and bottles were produced. The enterprise was successful and within twenty years there were eight factories in the Pittsburgh district producing glass to the value of $240,000. In 1883 natural gas began to replace coal and its low cost proved an effective factor in the growth of the industry.

The introduction of semi-automatic and automatic machinery was another great factor in reducing the cost and increasing the consumption of bottles and glassware, until in 1920 the total output of the United States was valued at fourteen times the output of

that of 1880. The value of glass products of Greater Pittsburgh is now enormous. According to the author, $13,000,000 worth of bottles and jars; $14,000,000 worth of window glass; $15,000,000 of table and decorated ware and over $10,000,000 worth of plate glass is produced annually in the Pittsburgh district. Many specialties, such as lighthouse and astronomical lenses, mirrors, etc., add considerably to the value of glass products produced there.

Echoes of Early Glass Making in New England

Two items from the Boston Gazette, quoted in "Old Time New England," tell a story of an early glass-making venture in the vicinity of Boston. The first is from the issue of Sept. 26, 1752, and reads as follows:

Tuesday last, a ship arrived here from Holland, with about 300 Germans, Men, Women & Children, some of whom are going to settle at Germantown (a part of Braintree) and the others in the Eastern Parts of the Province.—Among the Artificers come over in this ship, there are Numbers of Men skilled in making of Glass, of various sorts, and a House proper for carrying on that useful manufacture, will be erected at Germantown as soon as possible.

Apparently the venture throve. At least it caught the inquisitive fancy of the Colony, for a year later, in the Boston Gazette of Sept. 4, 1753, appeared this notice:

Notice is hereby given, That for the future none will be admitted to see the new manufactory at Germantown, unless they pay at least one shilling Lawful money; and they are desired not to ask above three or four Questons, and not to be offended if they have not a satisfactory answer to any of them.

Note.—The manufactory has received considerable Damage, and been very much retarded by the great Number of People which are constantly resorting to this House.

Tests of Wired Glass Windows

At the Underwriters' Laboratory maintained by the National Board of Fire Underwriters, Chicago, Ill., tests of various kinds of building glass are frequently made. The standard test for a window with metal frame glazed with standard wire glass made by any manufacturer whose name appears on the "List of Inspected Mechanical Appliances" is as follows:

The window is exposed to a standard fire on one side reaching a temperature of 1700° at the end of 60 minutes. The brick panel in which the window is mounted is then quickly removed from the furnace and subjected to a fire stream from a 1⅛ inch nozzle and 35 pounds pressure. Gas is used for fuel and a record is kept of all temperatures, both on the exposed and unexposed sides. Measurement of all deformations and warping together with all indications of failure are noted as the test progresses.

The term "standard wired glass" is used to designate glass considered standard against moderate exposure, in sizes not exceeding 720 inches, such as is made by the Mississippi Wire Glass Company, New York; Pennsylvania Wire Glass Company, Philadelphia, Pa.; Sergeant Glass Company, Sergeant, Pa.; Highland Glass Company, Washington, Pa.; Western Glass Company, Streator, Ill., and the Southwestern Sheet Glass Company, Okmulgee, Okla.

Put Your Street Address on Letterheads

The Post Office Department for some time past has been conducting an extensive, nation-wide campaign with a view to having mail plainly, completely and correctly addressed. The department is earnestly soliciting the cooperation of business organizations and individuals who can aid materially by including on their letterheads, order blanks, envelopes and other stationery, and in all advertisements, their complete street address or box number and postal station district. When this is not done and when the stationery gives only the name of the firm or a building a search must, in a great many instances, be made by the post office and railway mail clerks, for it is impossible for them to memorize all names and locations. Furthermore, names of buildings are frequently changed and without definite street number the mail may be assigned to the wrong carrier and delay ensue. The inclusion of the room number as well as the street number facilitates delivery, especially where a new carrier is assigned to the route. General acceptance by business men of these suggestions will save much time and enormous expense.

Lighting Fixture Manufacturers Fight Restrictions

Appealing to the United States Department of Justice to investigate evidence of what appears to be a conspiracy that threatens the existence of the electrical fixture industry of the country, the Associated Manufacturers of Lighting Fixtures has taken an aggressive offensive in New York City, writes Allen E. Beals in the current Dow Service.

On September 17 resolutions were adopted at the headquarters of the Electrical Board of Trade, Inc., by contractors and manufacturers from all parts of the metropolitan area at which the intention of organized employees to install no fixture of whatever kind or make, unless it has on it a union label, was read and condemned as being not only a menace to the industry itself, but one that will immediately increase the cost of nearly all kinds of electrical work in buildings of every type.

Resolutions were unanimously adopted "that the members of the Associated Manufacturers of Lighting Fixtures absolutely refuse to so label their product, and further, that owners, architects, engineers, contractors and the public be so advised and that their co-operation be requested in ignoring and opposing the demands of the union for a labeled product which can only mean an increased cost and interference in the orderly administration of the business of manufacturing lighting fixtures . . . . . and that this matter be referred to the United States Department of Justice and that the protection of this department be asked to prevent the destruction of the lighting fixture industry by what appears to be a conspiracy."

New Process for Manufacturing Gas

Announcement of the development of the Bean process for the manufacturing of non-poisonous heating and illuminating gas having twice the heat value and candle power of ordinary domestic gas, and manufactured at a cost less than that of making carburetted water gas, has been made by Col. E. E. Garrison, president of the Gas Bond and Share Corporation of America, New York City. The Bean process is the invention of Orestes U. Bean, inventor of the Bunsen furnace, who claims that it eliminates the low heat value carbon-oxygen combinations and leaves only the hydro-carbons and free hydrogen. Low cost of production is possible, it is asserted, because in the manufacture of the gas only the cheapest grades of heavy oil, such as refinery residuum, tars and "still bottoms" may be used and a considerable quantity of gasoline, containing 40 to 50% ethylene, is extracted from it. These heavy oils are vaporized in a column of superheated steam under automatic temperature and pressure regulation with the result claimed that a gas the equivalent of natural gas is produced.

Irish Free State Glass Trade

Somewhat belated, the Ministry of Industry and Commerce of the Irish Free State has recently issued a return showing the imports into the country during the first quarter of the present year, as compared with the similar period of 1924.

	January to March 1925		1924	
	Quantity	Value	Quantity	Value
Domestic and fancy glassware, cwt.	3,680	$59,640	3,495	$55,975
Illuminating glassware		24,115		22,150
Plate glass, sq. ft.	39,072	33,365	69,871	49,190
Other sheet glass, sq. ft.	653,693	70,000	410,929	59,935
Bottles (dutiable), gross	6,846	26,480	.....	.....
Bottles and jars (non-dutiable), gross	23,759	100,775	21,961	124,950
Glass and glassware, n.e.s., cwt.	655	17,870	1,431	32,580
		$332,245		$344,780

Foreign Commerce in July

Imports of glass products of all kinds in July totaled $1,570,411, a decline of $149,858 or about 4½% from the July, 1924, receipts. The decrease is accounted for by a reduction of $32,200 in window glass imported, compared with July, 1924, $28,006 in unsilvered plate glass; $18,474 in fluted, rolled, wired glass, etc.; $82,257 in blown glassware, bottles, etc.; $9,191 in cut or decorated glassware; $7,426 in lamp chimneys, globes, shades, etc., and other minor declines. These decreases were partly offset by increases

in the classification of bent, ground, colored glasses, etc., and table and kitchen utensils.

Exports in July were $719,533, details of which are given in the monthly summary on page 238. This was $47,586 below July, 1924. Window glass importations fell off about 50% below those of the corresponding month last year, plate glass about 46%, and other items showed smaller reductions.

Beverage Bottlers' Convention

The American Bottlers of Carbonated Beverages will hold their annual meeting and exhibition October 19-23, 1925, at Kansas City, Mo. A number of bottle manufacturers will exhibit their products, including: American Bottle Company, Toledo, O.; Charles Boldt Glass Company, Cincinnati, O.; Chattanooga Bottle & Glass Mfg. Company, Chattanooga, Tenn.; Graham Glass Company, Evansville, Ind.; Illinois Glass Company, Alton, Ill.; Laurens Glass Works, Laurens, S. C.; Root Glass Company, Terre Haute, Ind.; and Southern States Bottle Company, Shreveport, La. Several supply and equipment manufacturers will also exhibit, among whom are: Armstrong Cork Company, Pittsburgh, Pa., crowns; Crown Cork & Seal Company, crowns and bottlers' machinery, Baltimore, Md., and J. B. Ford Company, cleaners, Wyandotte, Mich.

Final Census Report on Glass Industry in 1923

The Bureau of the Census at Washington, of which W. M. Steuart is director, has completed the revision and amplification of the preliminary report made last year of the biennial census of the glass industry (published last fall in THE GLASS INDUSTRY) and a bulletin giving details has been issued by the Department of Commerce.

With few exceptions the figures given in the preliminary report have not been changed in the final one.

This was the third of four biennial censuses authorized for the years 1921, 1923, 1925 and 1927. Returns from the census questionnaires reating to the current year will not become available until late in 1926.

Copies of the 1923 report may be obtained from the Superintendent of Documents, Washington, D. C., at 5 cents each.

Plate Glass Production Still Breaking Records

The plate glass industry in the United States continues to hang up new high records of production. P. A. Hughes, of the Plate Glass Manufacturers' Association, announced that during the month of August, 10,328,029 sq. ft. of polished plate glass were produced. This is the first time in the history of the industry in the United States that a total of over 10,000,000 sq. ft. of polished plate glass has ever been made in one month. If this rate of production is maintained for the remainder of the year the total production will almost equal the total consumption recorded for the year 1924.

American Gas Association Convention

The seventh annual convention of the American Gas Association will be held during the first five days of the week beginning October 12. More than five thousand delegates are expected to attend. Many questions of importance to the gas industry will be discussed. A committee of industrial gas engineers will meet to report on the results of the national advertising campaign to increase the use of gas, which has been conducted during the past few months with excellent results.

Tariff Commission Investigates Sodium Silicofluoride

An investigation into the differences in cost of production of sodium silicofluoride in the United States and abroad has been ordered by the United States Tariff Commission for the purpose of assisting the President in the exercise of the powers vested in him by section 315 of Title III of the Tariff Act of 1922 respecting changes in tariff rates. Notice of a public hearing will be given shortly.

Holds Glass Despite Cut Artery

Rather than drop and break an expensive sheet of plate glass which he was helping to place in a store window, Robert Harwood, of Atlantic City, N. J., maintained his grip on the glass after it had slipped and severed an artery in his arm. Harwood, although in great pain, held to the glass for nearly two minutes until it was safely settled in place. He was then rushed to the Atlantic City Hospital. He will recover.—*New York Times.*

The new electric power line extending 34 miles from St. Louis to the Crystal City, Mo., plant of the Pittsburgh Plate Glass Company, whose electric power equipment was described in the May issue, was recently put into service. The line is operated at approximately 115,000 volts. The transmission line is said to have cost over $1,000,000 and the contract under which it is operated is reported to involve the purchase of $6,000,000 worth of power in 10 years and an annual delivery of 50,000,000 kw. hours.

Rentals in 179 cities, including New York, have been reduced about 3¼%, according to a bulletin issued by the United States Department of Commerce whose conclusions are based on a country-wide investigation.

Trade Activities

Work has been started on a small addition to the plant of the **Mississippi Glass Company,** on North Main street, St. Louis, Mo.

It is reported that the receivers of the **Interstate Window Glass Company** will move the general offices from Bradford, Pa., to Kane, Pa.

The Rivell Stained Glass Company has been incorporated at 595 Central avenue, Newark, N. J., with a capital of $125,000, by John Rivell, William D. Anton and William L. Rivell.

The J. R. Kilburn Glass Company, Chartley, Mass., has been incorporated with a capital of $50,000, by Jerome R. Kilburn, Carrie A. Kilburn and Winfred A. Kilburn, to manufacture glass.

The Dominion Glass Company's works on Delorimier avenue, Montreal, Canada, have been permanently closed and its equipment transferred to the company's plant at Wallaceburg, Ont., Canada.

The Holophane Glass Company, whose works are located at Lancaster, O., and the Holophane Illuminating Company, New York, have been merged and will assume the name of **Holophane Glass Company,** with main office at 342 Madison avenue, New York.

The Murano Glass & Mirror Company, 53 W. Jackson boulevard, Chicago, Ill., has been incorporated with a capital of $25,000, to manufacture and deal in glass, mirrors, etc. Incorporators are Harry I. Bergman, Charles Petahek and Lumir J. Schnal.

The Penn Window Glass Company, Pennsboro, W. Va., at a meeting of the stockholders, held September 12, decided to operate their plant this period and a gang was put to work making repairs, with the view to starting operations at an early date.

The Pittsburgh Plate Glass Company, Pittsburgh, Pa., has awarded a $130,000 contract for the erection of two buildings at its plant at Creighton, Pa. A two-story office building, 70 by 48 ft., will be erected, and a research laboratory, 106 by 43 ft., three stories in height. Both buildings will be of brick and tile with a steel understructure. Work will be started at once.

The Glass Machinery & Engineering Company has applied for a charter under the Pennsylvania state laws. The new company includes, J. W. Cruikshank, F. V. McKillop and H. A. Thrum. Its object is the manufacture, buying, selling and leasing of new and used machinery and of all supplies and merchandise used in and in connection with machine and manufacturing plants.

The Magnolia Window Glass Company, Fort Smith, Ark., which was recently incorporated with a capital of $75,000 by A. H. Scoggin, president; J. S. Hill, vice-president, and J. R. Miller, secretary-treasurer, recently began manufacturing operations. Repairs were made to the recently purchased plant

and equipment of the Model Window Glass Company and about 200 men are employed.

The Premier Window Glass Company, due to unfavorable conditions in the hand window glass business, have called a meeting of the creditors to be held at the company's plant at Pennsboro, W. Va., on October 1, at which time it is hoped to work out a plan which will ultimately pay the creditors in full. The call was signed by John B. Yates, president and treasurer, and V. O. Weekley, secretary.

The Fostoria Glass Company, Wheeling, W. Va., reports that at a recent meeting of the board of directors the following officers were elected for the ensuing year: W. A. B. Dalzell, president; C. B. Roe, vice-president; and W. H. Hicks, Jr., who was elected secretary, to succeed A. C. Scroggins, who has resigned on account of ill health. Mr. Hicks has worked up in the company from the position of office boy to his present position.

The wholesale glass business established by Vanhorne, Griffen & Co. in 1870 and conducted by Benjamin Griffen individually since 1904, at 9-11-13 Desbrosses street, 34-48 Vestry street and 443-445 Greenwich street, New York City, has been taken over by the **Benjamin Griffen Glass Corporation** of New York. The business will be continued at the above location under the management of Frank D. Fowler, who has been associated with the concern for many years.

A strike of fifty boys at the plant of the **Westmoreland Glass Company** at Grapeville, Pa., which tied up 15 shops and affected about 200 men, was called off after running nearly a week and the plant has resumed operations. The strike was caused by an order to the effect that employees must work right up to quitting time instead of stopping earlier to put away molds and tools. The men did not make any objection but the boys rebelled and walked out, tying up the entire production department of the plant.

The Brown Instrument Company reports from its main office in Philadelphia the opening of a branch at 363 New High street, Los Angeles, Cal., with S. F. Godfrey, recently of the Braun Corporation, as district manager. Articles of incorporation have been filed in California. This branch will carry stock and conduct its own accounting direct with its customers, maintaining a complete repair department for users of Brown pyrometers, recording thermometers, electric CO_2 meters, electric SO_2 meters, pressure gauges, tachometers, draft gauges, etc.

The American Window Glass Machine Company, Pittsburgh, Pa., on September 17 declared the usual quarterly dividend of 1¾% on the preferred stock and 1½% on the common stock. W. L. Munro, president, announced that the directors had decided to omit, at this time, the extra dividend of 1% on common stock which has been paid quarterly for the past two years. This action was deemed advisable on account of reduction in the price of window glass amounting to about 18% since August, 1924. Mr. Munro stated that the present demand for window glass is good and the outlook encouraging.

The bondholders' protective committee, representing the first mortgage five-year 8% sinking fund gold bonds of the **Interstate Window Glass Company,** announced early in September that more than half of the $2,221,500 bonds outstanding had been deposited with the Guaranty Trust Company of New York, and the Pittsburgh Trust Company, the depositaries. To insure prompt and decisive action by the committee and to enable all owners and holders of bonds to secure the benefits of concerted action the committee has extended the time within which deposits will be received by the depositaries to November 1, 1925.

Late in August, the employes of the **America Window Glass Company,** through the wage committee of the Window Glass Cutters' and Flatteners' Protective Association, agreed to extend their 1924-1925 wage scale agreement to September 20, 1926. Another group of glass workers, through the Window Glass Cutters' and Flatteners' Association of America, which represents about 600 members employed by the so-called independent window glass manufacturers, have also agreed to extend the present wage contract with revision of certain working condition.

A new corporation, the **Kittanning Plate Glass Company,** has been incorporated under the laws of Delaware, with an authorized capital of 70,000 shares of 7% cumulative preferred stock and 70,000 shares common stock of nominal value, to manufacture polished plate glass. The company reports that it has purchased a tract of land about 1,200 by 2,000 ft., including the old Kittanning Fair Grounds at Kittanning, Pa., on which it will build a modern plant with a capacity of 10,000,000 sq. ft. of plate glass per year. It is planned to operate the plant with electric power to be obtained from the West Penn Power Company. A prospectus giving further information has been issued from the company's office.

Industrial Publications

Morris Overhead Railway Systems. A folder issued by Herbert Morris, Inc., Buffalo, N. Y., describing their overhead trolley system and illustrating some of its special features.

Brown Indicating and Recording Tachometers. Catalog No. 44. A twelve-page booklet illustrating and describing the Brown line of tachometers for measuring or counting the revolutions of shafts, etc., per minute.

The American Blower Company have issued Bulletin No. 3,506, entitled "ABC" Steel Plate Exhaust Fans. These fans are especially adapted for removing shavings, sawdust, dust from grinding and buffing wheels, conveying material, removal of smoke and fumes, and similar requirements. The bulletin may be obtained by writing to the American Blower Company, Detroit, Mich.

Air—Its Value. A small booklet isued by the Garden City Fan Company, 1841 McCormick building, Chicago, Ill., in which air conditioning, ventilation, heating, cooling and removal of refuse material in factories is discussed. General and elementary information is given regarding fans and their application for different purposes. Copies may be obtained from the company's office.

Review of Published Statistics. Niles & Niles certified public accountants, 60 Broadway, New York, have published a booklet relative to the cost of merchandise distribution, rates of turnover and fluctuations in manufacturing employments in the United States. This review summarizes the results of the study by various organizations of the economic principles governing and affecting the cost of merchandise distribution. Copies may be obtained from the office of Niles & Niles.

Brown Automatic Temperature Control Instruments. Catalogue No. 87. A 40-page catalog giving the latest information about, and illustrating many actual installations of Brown instruments for automatic temperature control in numerous industries, including one on a revolving pot glass furnace. Descriptions of the controlling instruments are given; also wiring diagrams for furnaces heated by electricity or by gas or oil. The Brown automatic signalling pyrometer, equipped with colored signal lights, is also illustrated.

Brown Recording Pressure and Vacuum Gauges. Catalog No. 74. The Brown Instrument Company, 4513 Wayne avenue, Philadelphia, Pa., has issued a 32-page catalog illustrating and describing in considerable detail the chief features of Brown Recording Pressure and Vacuum Gauges. Among the products listed are the Duplex recording pressure gauge, new flush-type case for panel boards, automatic control, signal and alarm recording pressure gauges, portable all-metal recording vacuum and pressure gauges, differential draft gauges, protecting cases, oil seals, charts, chart files and supplies, recording pyrometers, etc.

Personals

J. Howard Fry, vice-president of the Libbey Glass Manufacturing Company, Toledo, O., has resigned and plans to locate in Florida, where he will enter an entirely different line of business.

George O. Smith, glass chemist, who has been located at Trenton, N. J., advises that his address has been changed to 720 Gorsuch avenue, Baltimore, Md.

Professor Charles F. Binns of Alfred University, a former president of the American Ceramic Society and active in build-

ing up the society when it was young, will on December 12, deliver a lecture on "Eastern Engobe Wares" at the Metropolitan Museum of Art, New York.

Deaths

Harry M. Felker

Harry M. Felker, for many years connected with the glassware trade in Pittsburgh and New York, and who was one of the best known and best liked men in the business, died recently at the age of eighty years at his home in Pittsburgh. At one time he represented Adams & Company, now known as Factory A of the United States Glass Company, and the Rochester Tumbler Company, and later the United States Glass Company. During recent years Mr. Felker was the representative in Pittsburgh of the Berkeley Glass Sand Company, Berkeley Springs, W. Va.

James D. Wilson

James D. Wilson, one of the early glass manufacturers of Tarentum, Pa., and an official of the Tarentum Glass Company until that plant was destroyed by fire, died on August 24, at the age of 77 years.

Hiram F. Kinsley

Hiram F. Kinsley, 69 years of age, formerly connected with the Cleveland Window Glass Company and later in the paper business, died on August 30 at his summer residence in Cleveland.

What Our Advertisers Are Doing

A number of blowing machines have lately been installed by the **O'Neill Machine Company,** Toledo, O., at the plant of the C. L. Flaccus Glass Company, Tarentum, Pa., and more will be added within a short time. Quite recently a third O'Neill machine was added to the equipment of the Ohio Glass Products Company, Massillon, O., and a fourth machine will be put in within a short time.

The Chapman-Stein Furnace Company, Mt. Vernon, O., recently received an order from the Yunck Glass Company, Orange, N. J., for a recuperative day tank. The recuperator for this type of tank takes the place of a stack and is all above the ground level. The first Chapman-Stein recuperator for this plant was installed on a small closed-pot furnace. A contract has also been placed by the Indiana Glass Company, Dunkirk, Ind., for an oil-fired recuperative day tank to be built with a Chapman-Stein refractory tile recuperator. This tank will have a capacity of 2½ tons a day.

The Amsler-Morton Company, Pittsburgh, Pa., recently closed a contract for one 6 ft. 6 in. by 70 ft. 0 in. Amco type "C" continuous lehr with the Louis C. Tiffany Furnaces, Inc., Corona, L. I. Another contract was received from the Pyrograph Advertising Sign Corporation, New York, for one 4 ft. by 105 ft. decorating lehr, a 105 ft. dryer, and an Amco fuel oil system to be built at their Baltimore plant. The lehr is of special design and arranged for two operations, viz.: decorating and the bending of flat glass. The latter operation requires a temperature of approximately 1250° F. inside the muffle. This installation is somewhat different from the usual decorating lehr in that the dryer is used in conjunction with it for drying the decorations or designs before firing takes place. The dryer is of the same length and width as the lehr and parallel to it. No auxiliary fires are used in it however, it being heated by the waste heat from the decorating lehr.

In addition to the above the Amsler-Morton Company recently secured contracts for the construction of a large tank for El Vulcano, Callao, Peru, S. A.

Coming Meetings

AMERICAN CERAMIC SOCIETY fall meeting will be held in connection with the chemical exposition at New York City, October 1, 1925, and the annual meeting at Atlanta, Ga., February 8-13, 1926.

ASSOCIATED GLASS AND POTTERY MANUFACTURERS AND PITTSBURGH GLASS AND POTTERY EXHIBIT, January 11 to 30, 1926, at Pittsburgh.

THE STAINED GLASS ASSOCIATION OF AMERICA, formerly the National Ornamental Glass Manufacturers Association, will hold its next annual convention in the summer of 1926 in Washington, D. C., which will be followed by a trip to Europe.

The annual convention of the AMERICAN BOTTLERS OF CARBONATED BEVERAGES will be held at Kansas City, Mo., October 19 to 23.

TENTH EXPOSITION OF CHEMICAL INDUSTRIES will be held at Grand Central Palace, New York, September 28 to October 3.

THE FOURTH NATIONAL EXPOSITION OF POWER AND MECHANICAL ENGINEERING will be held at the Grand Central Palace, New York, November 30 to December 5.

What the World Wants

Specific inquiries for American goods received in the Department of Commerce.

Porto Rico. 16653, glassware.

Germany. 16515, glass industry machinery, especially mirror-beveling machines.

Australia. 16554, glassware.

New Zealand. 16881, flint and ruby glass novelties and dishes.

Italy. 16882, glassware.

Inquiries Received

For Further Information Address THE GLASS INDUSTRY

289. We are in need of lenses of different sizes and types for highway reflective signs. (Aug. 26.)

290. Can you give me the name of a manufacturer furnishing door glass with beveled edges that are pressed, not ground. (Sept. 14.)

291. Can you give us the present address of Adam Ogint to whom United States patent No. 1,538,903 was recently issued. (Sept. 9).

292. Kindly give us the names of manufacturers of colored glass, also any information that you may have where we may buy colored cullet. (Sept. 18.)

Glass Stock Quotations

Reported by Moore, Leonard & Lynch, Union Trust Building, Pittsburgh, Pa.

PITTSBURGH STOCK EXCHANGE, SEPTEMBER 23, 1925

	Bid	*Ask*	*Last*
American Window Glass Machine, com.....	84	85	83
American Window Glass Machine, pfd.....	94	95	94
American Window Glass, preferred.....	113	117	114
United States Glass.....	13	14	13½
Pittsburgh Plate Glass.....	268	275	270
Standard Plate Glass, common.....	6½	7	6¼
Standard Plate Glass:			
Preferred cumulative	45	52	45
Prior	80½	90	81

Glass stocks on the Pittsburgh Stock Exchange ruled lower reflecting increased foreign and domestic competition, and price cuts in the trade. Standard Plate Glass omitted the dividend on the preferred and American Window Glass Machine common cut off the $1 extra a quarter making the dividend rate 6 per cent instead of 10 per cent.

WHEELING STOCK EXCHANGE, SEPTEMBER 23, 1925

	Bid	*Ask*	*Last*
Hazel-Atlas	38	39	39½
Imperial	..	75	72
Fostoria	140	..	140
Central	80	..	81

The Wheeling stocks are moderately active. Hazel-Atlas has increased operations to 75 per cent and is being bid for at a slight increase over last month.

TOLEDO STOCK EXCHANGE, SEPTEMBER 23, 1925

	Bid	*Ask*	*Last*
Owens Bottle Machine, common.....	58	58⅝	58¼
Libbey-Owens Sheet Glass, common.....	195	197	196
Libbey-Owens Sheet Glass, preferred.....	114	116	115

Current Prices of Glass-Making Materials

Quotations furnished by various producers, manufacturers and dealers.

September 22, 1925

		Carlots	Less Carlots
Acid:			
Citric	lb.	..	.46
Hydrochloric (HCl) 20° carboy ext.	lb.	..	.02
Hydrofluoric (HF) 60% (lead carb.)	lb.	..	.13½
52% and 48%	lb.	..	.10-.11½
Nitric (HNO_3) 38° carboy ext. Per 100 lb.		..	5.25
Sulphuric (H_2SO_4) 66°	ton	15.00	..
Tartaric	lb.	..	.29
Alcohol, denatured	gal.	..	.65
Aluminum hydrate ($Al(OH)_3$)	lb.	.06	.07
Aluminum oxide (Al_2O_3)	lb.	..	..
Ammonium fluoride (NH_4F)	lb.	..	.23
Ammonia water (NH_4OH) drums	lb.	..	.05-.06¼
Antimony, metallic (Sb)	lb.	..	.18
Antimony oxide (Sb_2O_3)	lb.	..	.18
Antimony sulphide (Sb_2S_3)	lb.	..	.18
Arsenic trioxide (As_2O_3) (dense white), 99%	lb.	.04	.04½
Barium carbonate ($BaCO_3$)			
Precipitated	ton	..	..
Natural, powdered	ton	42.00	45.00
Barium hydrate ($Ba(OH)_2$)	lb.	..	.05
Barium nitrate ($Ba(NO_3)_2$)	lb.	..	.09
Barium selenite ($BaSeO_3$)	lb.	..	..
Bone ash	lb.	.05½	.06½
Borax ($Na_2B_4O_7 \cdot 10H_2O$)	lb.	.04¾	.05-.05½
Boric acid (H_3BO_3)	lb.	.09	.09¾
Refined	lb.	..	..
Cadmium sulphide (CdS)—			
Red	lb.	..	1.25
Orange	lb.	..	1.10-1.25
Yellow	lb.	..	..
Chromium oxide (Cr_2O_3)	lb.	.31	.33
Cobalt oxide (Co_2O_3)			
In bbls.	lb.	..	2.10
In 10 lb. tins	lb.	..	2.20
Copper oxide			
Red (Cu_2O)	lb.	..	.30
Black (CuO)	lb.	..	.25
Black prepared	lb.	..	.30
Cryolite ($Na_3Al\ F_6$)	lb.	..	.09⅛
Epsom salts ($MgSO_4$) Per 100 lb.		..	1.40
Feldspar—			
100 mesh	ton	12.50-20.00	16.00-22.00
80 mesh	ton	..	..
40 mesh	ton	..	..
Fluorspar (CaF_2)—			
Powdered white, 95%	ton	40.00	..
" " 90%	ton	38.00	..
Formaldehyde	lb.	.08¾	.09¼
Graphite (C)	lb.	..	.04-.07
Iron oxide—			
Red (Fe_2O_3)	lb.	..	.02
Black (FeO)	lb.	..	..
Kaolin (f.o.b. mine)	ton	10.00	..
English, lump, f.o.b. New York	ton	14.00-23.00	..
Lead chromate ($PbCrO_4$)	lb.	..	..
Lead oxide (Pb_3O_4) (red lead)	lb.	12¼	.12¼-.12½
Litharge (PbO)	lb.	.11¾	.11¾-.12

		Carlots	Less Carlots
Lime—			
Hydrated ($Ca(OH)_2$) (in paper sacks)	ton	12.50	..
Burnt (CaO) ground, in bulk	ton	9.00	..
Burnt, ground, in paper sacks	ton	11.00	..
Burnt, ground, in 280 lb. bbls.	Per bbl.	2.15	2.30
Limestone ($CaCO_3$)	lb.	..	..
Magnesia (MgO)—			
Calcined, heavy	lb.	..	..
Light	lb.	..	..
Magnesium carbonate ($MgCO_3$)	lb.	.03¼	.03½
Manganese 85% (MnO_2)	lb.	.03½	.03¾
Nickel oxide (Ni_2O_3), black— for nickel content	lb.	..	.35
Nickel monoxide (NiO), green— for nickel content	lb.	..	.35
Plaster of Paris, bags	ton	..	19.00
Potassium bichromate ($K_2Cr_2O_7$)—			
Crystals	lb.	..	.08¾
Ground	lb.	..	..
Potassium carbonate—			
Calcined (K_2CO_3) 96-98%	lb.	.06¾	.07
Hydrated 80-85%	lb.	.06	.06½
Potassium chromate (K_2CrO_4)	lb.	..	..
Potassium hydrate (KOH) (caustic potash)	lb.	..	.07⅛-.07¾
Potassium nitrate (KNO_3) (gran.)	lb.	.06⅛	.06¾
Potassium permanganate ($KMnO_4$)	lb.	.14½	.16
Powdered blue	lb.	..	.24-.28
Rochelle salts, bbls.	lb.	..	.20
Rouge	lb.	..	..
Rutile (TiO_2) poydered, 95%	lb.	.20	.25
Salt cake, glassmakers (Na_2SO_4)	ton	22.00	..
Selenium (Se)	lb.	..	2.10
Silver nitrate ($AgNO_3$)	oz.	..	.49¾
Soda ash (Na_2CO_3) dense, 58%—			
Bulk	Flat per 100 lb.	1.35-1.40	..
Bulk, on contract	Flat per 100 lb.	1.35	..
In barrels	Per 100 lb.	1.69	2.40
In bags	Per 100 lb.	1.45	..
Spot orders .05 per 100 lbs higher			
Sodium bichromate ($Na_2Cr_2O_7$)	lb.	..	.06¾
Sodium hydrate (NaOH) (caustic soda)	Per 100 lb.	3.20	3.90
Sodium nitrate ($NaNO_3$)—			
Refined (gran.) in bbls.	lb.	.03⅞	.04⅛
95 per cent.	Per 100 lb.	2.55	2.75
Sodium selenite (Na_2SeO_3)	lb.	..	..
Sodium fluosilicate (Na_2SiF_6)	lb.	..	.04¾
Sodium uranate (Na_2UO_4)	lb.	..	1.15
Sulphur (S)—			
Flowers, in bbls.	Per 100 lb.	3.35	3.65-3.90
Flowers, in bags	Per 100 lb.	3.00	3.30-3.55
Flour, heavy, in bbls.	Per 100 lb.	2.50	2.80-3.05
Tin chloride ($SnCl_2$)) (crystals)	lb.	..	.41
Tin oxide (SnO_2) in bbls.	lb.	..	.63
Uranium oxide (UO_3), 100 lb. lots	lb.	..	1.15
Zinc oxide (ZnO)	lb.	.07½	.07¾

Monthly Summary of United States Foreign Commerce in Glass

EXPORTS

Corrected to August 24, 1925

	July 1924 Quantity	July 1924 Value	July 1925 Quantity	July 1925 Value	Seven Months Ending July 1924 Quantity	Seven Months Ending July 1924 Value	Seven Months Ending July 1925 Quantity	Seven Months Ending July 1925 Value
Glass and glass products (total)	.....	$767,099	.....	$719,513	.....	$5,212,079	.....	$5,087,992
Plate and window glass—								
Window glass, common, box 50 sq. ft.	3,344	$18,089	1,960	$9,589	24,840	$110,656	16,385	$94,729
Plate glass, unsilvered, sq. ft.	193,031	58,051	101,583	31,153	1,215,050	350,919	851,036	235,767
Other window and plate glass, n.e.s.	144,028	12,780	91,288	18,015	1,170,668	127,493	1,173,298	137,898
Glass containers (bottles, vials and jars) lbs.	5,686,753	265,499	4,703,465	243,734	34,959,029	1,698,819	40,535,125	1,808,086
Table glassware, plain lbs.	1,616,271	169,293	1,632,523	173,369	9,314,163	1,037,836	9,945,255	1,013,746
Table and other glassware, cut or engraved lbs.	89,205	17,429	63,193	16,909	285,734	85,648	295,051	87,371
Glassware for lighting—								
Lamp chimneys and lantern globes lbs.	226,592	37,389	144,994	29,420	1,195,185	222,346	1,145,274	202,260
Globes and shades for lighting fixtures lbs.	92,664	25,416	151,766	40,754	740,553	226,952	914,849	274,505
Lamps and other illuminating devices, chiefly of glass lbs.	78,040	13,990	79,183	17,013	640,844	181,618	496,341	136,129
Chemical glassware lbs.	20,045	17,707	18,408	17,284	120,941	100,807	128,583	103,812
Electrical glassware, except for lighting lbs.	170,981	20,889	221,478	25,308	1,697,405	160,271	1,902,715	163,149
Other glassware, n.e.s. lbs.	608,026	110,567	466,014	96,965	5,759,642	908,714	4,333,037	830,540

IMPORTS

Corrected to August 24, 1925

Glass (total)	.....	$1,720,269	.....	$1,570,411	.....	$12,070,582	.....	$10,156,518
Cylinder, crown and sheet—								
Unpolished, lbs. dut.	3,691,296	$211,193	3,571,106	$178,993	19,466,940	$1,140,674	30,366,660	$1,601,166
Bent, ground, beveled, colored, painted, etc., and polished dut.	.....	37,636	.....	43,848	.....	313,484	.....	343,507
Plate Glass—								
Unsilvered, sq. ft. dut.	1,372,655	790,583	1,697,515	762,577	11,353,013	7,116,613	9,972,121	4,789,616
Fluted, rolled, etc., or silvered, or containing wire netting, sq. ft. dut.	343,707	30,766	83,587	12,292	1,864,605	230,868	712,132	109,372
Containers—bottles, vials, etc. dut.	.....	11,420	.....	14,419	.....	137,149	.....	102,604
Table and kitchen utensils, lbs. dut.	19,809	4,098	45,665	12,061	503,902	104,184	254,890	58,436
Glassware, cut or decorated, lbs. dut.	364,726	177,079	361,673	167,888	1,951,504	933,809	2,069,093	1,107,313
Blown glassware, n. e. s., lbs. dut.								
Bottles, ornaments, etc., lbs. dut.	752,779	216,209	456,735	130,952	2,586,799	834,748	1,596,029	516,142
Bulbs or electric lamps, number dut.	1,413,470	23,007	1,316,723	15,581	7,809,748	114,868	11,889,966	120,181
Chimneys, globes, shades, etc., lbs. dut.	417,887	86,284	429,834	83,614	2,693,072	456,493	3,058,801	648,000
Articles and utensils for chemical, scientific, and experimental purposes, lbs. dut.	85,714	30,546	126,546	36,510	558,899	188,055	513,730	176,681
Other glassware dut.	.....	101,448	.....	111,676	.....	499,637	.....	583,506